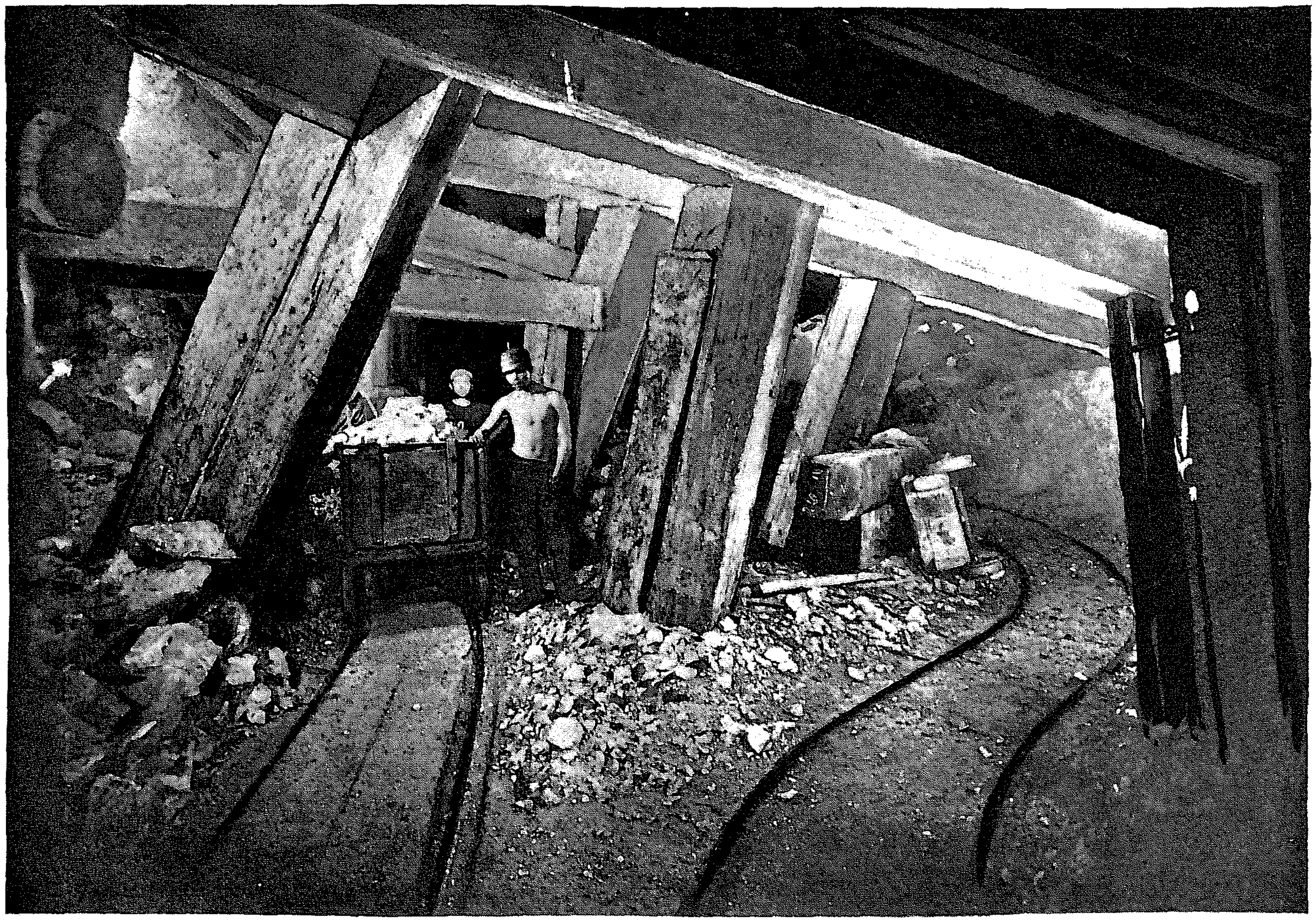
and skip box, made of iron three-eighths inch thick, 6 inches high, the 2 flanges or checks of each shoe extending 2.75 inches beyond the face of the guide strap. The inner faces of the flanges are protected by false plates riveted to the shoes. The inner surfaces of each pair of plates when worn down are easily replaced. A drawbar 2.25 inches in diameter passes through the upper end of the bale or frame. It has a vertical play of 9 inches, and is prevented from turning by a key. To the lower end of the drawbar double nuts are screwed to hold it within the frame, while 2 nuts on the upper end hold the clevis to which the shackle is attached. The top of the guide frame is covered by a bonnet or hood of three-sixteenths-inch sheet iron, fastened to the frame by bolts. The bonnet has hinges at the distance of 6 inches from its ridge, to allow its being opened if necessary. The skips are provided with a safety arrangement, alike on all skips and cages except the timber cages, which are without it. The arrangement referred to consists of 2 round steel bars, 1.5 inches in diameter, extending across and beyond the frame of the cage far enough to embrace within their ends the guide rods, also called "skip rods", which are sticks of timber 3.75 inches square, planed, and fastened to each side of the shaft, extending from top to bottom. On the ends of the round steel bars are placed and keyed fast cast-iron eccentrics having a serrated surface on a part of their circumference. The bars are supported by and revolve freely in eyes forged on each side of the upright members of the frame of the skip or cage. A chain pulley is keyed to each bar at the center, to which a three-eighths-inch chain is made fast, passed around it, and attached to the drawbar or lifting bolt. The length of this chain is such that when the drawbar takes the weight of the cage it causes the shafts carrying the eccentrics to partly revolve, bringing the smaller radii of the eccentrics opposite each other. As there are no teeth on this part of the circumference of the eccentrics, there is sufficient space left between to clear the wooden guide rods. The bars while turning into this position act on 2 strong steel spiral springs, 1 on each side of the corresponding eccentric, drawing their coils closer together and exerting a force of several hundred pounds. The moment the strain is removed from the drawbar or lifting bolt, in the event of resting the cage or skip on some support, or in case of the suspending rope parting or breaking, the springs uncoil with sudden force, turn the shafts or cam bars, and bring the greater radii of the 2 opposing eccentrics closer together, their teeth grasping the wooden guide rods with stronger force the heavier the attached weight, and preventing the skip or cage from further descent. The weight of these skips complete is 1,700 pounds. Their capacity is 3,000 pounds of rock. Skips of the same size are used at the Santa Isabel shaft. Shafts with small hoisting engines have skips of proportionate size, holding 2,000 or 1,000 pounds only, but the construction is similar to those of the largest size, and all are provided with safety attachments. For hoisting water, self-dumping skips, working automatically, have been used at the Santa Isabel and Buena Vista shafts.

For hoisting and lowering men at the Randol and Santa Isabel shafts double-deck cages are employed. They contain 2 platforms or floors 2 feet 7 inches square, made of quarter-inch sheet iron, 6 feet apart, hanging by 4 round iron bars, 1 inch in diameter, from 2 bars that are fastened to the guide frame with three-quarter-inch bolts. These cages are provided with bonnets and safety clutches. Each deck holds 6 men. To send timbers into the Randol mine a cage with a single platform and without bonnet or safety apparatus is used. The guide frame is 8 feet long and 2 feet 8 inches square. The cage at the Buena Vista shaft is similar to the one used for men at the Randol shaft. It has in addition track irons on each deck for the cars. This double-deck cage weighs 1,800 pounds.

The Buena Vista shaft is provided at the top and at the 2,100-foot station with landing chairs to support the cage while the cars are run off or on the platform of the cage. They consist of 4 wrought-iron knees, 2 on each side of the shaft, into which they project, and are situated just below the floor of the station. They are withdrawn from projecting in the shaft by a lever keyed to the shafts, which are connected with the knees by iron rods. By moving the lever backward the shafts partly revolve, withdrawing the knees and leaving the way clear for the descending cage. The "lander" or station tender operates this lever, a catch being also provided to keep the lever in position when withdrawn, if required. Automatic covers close the top of the Buena Vista shaft when the cages are down.

The rock and ore from the mine are hoisted at the Randol shaft to the 800-foot adit level, and thence run out in cars drawn by mules, as already mentioned. This adit level, or 800 crosscut from the Randol shaft, is 700 feet long. From the mouth of the crosscut begins an elevated car track, which leads to the planilla or ore-cleaning shed and to the waste dump. At the 800-foot station a sheet-iron door or apron, movable on hinges, is secured against the open side of the shaft in such a way that by the movement of a lever the upper edge of the apron will project about 4 inches inside of the shaft, while the lower edge will project outside and over the top of a car that stands in place on the track alongside of the shaft. The loaded skip having been hoisted a couple of feet above this 800-foot station, the apron is brought into position by the lever, and the skip is lowered down until it rests with the angle iron on its bottom against the upper edge of the apron. The skip door is then opened by throwing aside the key or pawl and swinging the latch bar from the catches, when the whole charge drops into the ready car. 1 man at the station attends to this work. 2 cars make a train, which is drawn by a mule, attended by a driver. A loaded train is taken out and the empty cars returned while another train is filled by the man at the station. A switch track at the station gives room for the management of the trains. The loaded train, having arrived at the mouth of the adit, is taken in charge by a man called the "car dumper". He pushes the cars to their destination and dumps the loads at the different screens when loaded with ore, or discharges them over the waste dump if they contain waste rock, called "tepetate". In this way the work goes on without interruption day and night.



TRAMMING, 1,500-FOOT LEVEL, RANDOL SHAFT, NEW ALMADEN QUICKSILVER MINE.

At the other shafts, where the ore or waste rock is brought to the top of the shaft and where the cleaning floors for ore and the waste dump are near at hand, the discharging of the skips and the tramming of the loaded cars, etc., is done by 1 man, called the "lander", using only 1 car, which can be discharged while another skip load is being hoisted to the surface.

The arrangement for loading skips at the different stations of the Randol and the Santa Isabel shafts is as follows: Filling the skips with the material to be hoisted from the Randol shaft is done by contract. The prices for skip filling range from 8.5 to 10 cents per ton. 6 men at the Randol shaft form a company, who attend to all skip filling at the different stations of that shaft. At other shafts, where less rock is hoisted, skip filling is done by day's labor. The stations at all the shafts excepting the Buena Vista are of 2 stories. In the Randol and Santa Isabel shafts a dump car is used for filling the skip. This car stands on the lower platform, on a short track facing the shaft. It is made entirely of iron and holds exactly 1 full charge for the skip, or 3,000 pounds. The dump car is of the same size as the skip. The car is open in front, a short board being placed in the forward end to keep the rock in place while the car is being filled. The forward end of the rails that form the track are bent upward, so that the car can be pushed only a short distance ahead, just sufficient to overhang the skip ready for the load. The advantage of this dump car is that the skip fillers can prepare the load while the skip is being hoisted and lowered again, and a charge is ready by the time the skip returns to the station. The dump car is then run forward on its short track and its charge dumped into the skip. To hold the skip in place while being filled and to relieve the hoisting rope from the sudden shock of the falling load a bar is placed in the shaft, which is held at one end by a bolt run through an eye in the bar at one end, and through 2 stationary ring bolts fixed to the side of the shaft nearest the station, while the other end of the bar is allowed to drop against the rear side of the shaft, the bar being of such length as to lay at an angle to suit the sloping bottom of the skip. In shafts that are not provided with dump cars skips are filled by shoveling.

Lighting the mines.—For lights candles are used. The trammers often prefer to use small lamps burning fish oil, as they better withstand the draft. The shaft houses are lighted up at night by large headlights that throw a strong light against the gallows frame and upon the hoisting rope.

Ventilation.—All the different levels of the mine are connected by the shafts and winzes, which insures the free circulation of air through all its workings. In long crosscuts and drifts remote from the main air currents the air at times becomes hot and vitiated and artificial ventilation is necessary. This is usually accomplished by doors, which force the air current to take a certain desired direction, or by wooden boxes or sheet-iron pipes so arranged that the air is compelled to pass through these conduits toward the face of the drift. Where these means fail, blowers or fans, in connection with wooden boxes or sheet-iron pipes, are used. Blowers for small drifts, upraises, or winzes are driven by hand power. When a greater or more constant volume of air is needed, these fans or blowers are driven by engines, worked by steam only when the power is applied on the surface. For underground power compressed air only is used. As nearly all the underground workings are connected by the different shafts, the natural ventilation takes place by upcast or downcast currents, aided by the different adit levels.

The main tunnel (300 level) of the old mine connects by winzes with all the upper workings above that level, and by an interior shaft, the Main shaft, with all levels down to the 600-foot level, and thence by the Junction shaft, also an interior shaft, with the 800 level, or Day tunnel. The Day tunnel connects with the Washington shaft, and by a branch drift with the Randol shaft. The Washington shaft connects on the 1,100 level by an incline with the 1,400-foot level of the Santa Isabel shaft. The Santa Isabel shaft connects on the 1,400 level with the Randol mine, and through upraises with the Saint George shaft. The 1,700-foot level of the Santa Isabel connects by a long crosscut with the Randol shaft, and by an incline shaft the 1,900-foot level of the Santa Isabel is also connected with this crosscut (1,700). The Randol shaft connects through a winze from the 1,900 level with the 2,100 level, Buena Vista. The 2,100-foot level of the Buena Vista and Santa Isabel are also connected. The adit to the Randol shaft, or 800 crosscut, aids also in the ventilation, so also does the adit or water tunnel on the 1,200 level, Buena Vista. The levels from the different shafts are also connected by numerous winzes, and partly also by passages through some of the old ore stopes.

The Santa Isabel shaft is a downcast shaft (collar 728 feet below datum), and acts so at all times. The Buena Vista shaft is always upcast (collar 885 feet below datum), taking the current of air from the Santa Isabel. Part of this current comes through the Buena Vista shaft to the surface; another part ascends through the 2,100-foot incline into the Randol workings.

The Randol shaft, 426 feet below datum, acts at all times as an upcast shaft from the bottom level (1,800-foot level) to the 800 adit or crosscut. The air current through the 800 adit, or crosscut, of the Randol shaft changes its direction according to the state of the weather on the surface. On cold days the current rises in the shaft and the air comes in through the crosscut, while on warm days the current is reversed.

The Randol shaft takes the air current from the 2,100 level, Buena Vista, as already mentioned, from the Santa Isabel through the 1,700 crosscut mainly, and also from the incline shaft connecting the 1,700 crosscut with the 1,900 level, Santa Isabel. The Saint George shaft, 570 feet below datum, is an upcast shaft, taking the current from the Randol shaft and partly from the Santa Isabel shaft. The Washington shaft, 176 feet below datum, is an upcast shaft in cold weather and downcast on warm days. The air current passes out of the Day tunnel on warm days, and reverses on cold days. So also acts the current of air in the incline connecting the 1,100 level of the Washington shaft with the 1,400 level, Santa Isabel, being downcast on warm days and upcast on cold days. These shafts and tunnels form the main arteries for the ventilation of the whole mine.

TEMPERATURE.

The temperature at different points in the mine is naturally much influenced by the air currents. The 1,700 crosscut which connects the Santa Isabel shaft with the Randol shaft is the coolest part of the deep underground passages. It averages 60° fahrenheit in summer and 50° in winter. The highest temperature observed in any part of the mine was 88.5° fahrenheit. Some observations gave the following data (the degrees are fahrenheit):

SANTA ISABEL SHAFT.—On December 14, 1888, the temperature at the surface was 55°. At the 1,400 station, near shaft, 575 feet below surface, it was 58°. In the 1,400 crosscut from this shaft, at a point 800 feet distant from the shaft, it was 78°. At the face of the 1,400 drift south from the crosscut, at a distance of 2,600 feet from the shaft, with ventilation through air boxes 10 by 20 inches in section, the observed temperature was 85°. It must be noticed that this observation was taken while the drift was being worked, as the temperature is much less after only 12 hours interruption of the work. In the 1,400 level west (a branch of the 1,400 crosscut) and about 550 feet distant from a winze coming up from the 1,500 level of the Randol shaft, the drift being supplied with air by an 11-inch pipe, the observed temperature was 84°.

SAINT GEORGE SHAFT.—On December 14, 1888, the temperature at the surface was 55°. At the 1,000 level, near station (386 feet below surface), it was 76°. The Saint George shaft acts as an upcast shaft. At the 1,200 level, in an upraise 20 feet above the drift, it was 82°. This observation was taken while the upraise was being worked. The point was remote from shaft or winze and had no artificial ventilation.

RANDOL SHAFT.—On December 13, 1888, the temperature at the surface was 51°, the weather rainy. At the 1,300 station, near shaft (826 feet below collar), the temperature was 72°. At the 1,300 level, in an upraise 20 feet above the level and 1,200 feet distant from the shaft, the temperature was 77° while the upraise was worked. At the 1,400 station, near shaft (925 feet below collar), it was 75°; at the 1,400 level, at a point 500 feet north from the shaft, 76.5°; at the 1,400 level, at a point 800 feet north from the shaft, 78°, and near the same place, standing in the air current, coming up from a winze, the temperature was 76°. At the face of an upraise from the last observation point, and at about 30 feet above the level, the observed temperature reached 86°. This upraise was then being worked. At the 1,500 level, in an upraise about 1,500 feet distant from the shaft and about 40 feet above the level, the temperature reached 88.5° while the miners were at work. On the 1,600 level, west of the shaft about 1,000 feet and in good air current, the temperature was 73°. At the 1,600 station, at shaft, it was 74° (1,125 feet below surface), while the temperature on surface was 54°.

For ventilating purposes there are on hand 1 No. 2 and 1 No. 3 Baker rotary pressure blower, 1 Root blower, and 1 Blackmann power ventilator and exhaust wheel of 5 feet diameter. For special purposes exhaust fans are constructed similar to the Guibal fans of old construction. One of these fans, 12 feet in diameter, had been erected at one time over the Washington shaft for the purpose of regulating the ventilation on the 1,400 crosscut from the Santa Isabel shaft, while much carbonic-acid gas was present, and very satisfactory results were obtained with small cost. The fan was driven by a small steam engine of 6 horse power. All the communications with the Washington shaft were closed except the one with the 1,400 crosscut, Santa Isabel.

The length of drifts, winze, and shaft which this current had to pass through was: 1,400 crosscut to foot of incline, 2,490 feet; length of incline (235 feet perpendicular elevation), 300 feet; 1,100 level, Washington, 950 feet; shaft to the surface, 865 feet; or a total of 4,605 feet. The air in the 1,400 crosscut was mixed with carbonic-acid gas to such an extent that a lighted candle would go out almost instantly, and the natural draft was insufficient to set the column of heavy air in motion. The 12-foot exhaust fan was started on May 23, 1888, at noon, the fan making 40 revolutions per minute, and at 2 o'clock the same afternoon the air in the crosscut was found pure. The exhaust flue had an area of 19.125 square feet (perimeter 17.5 feet); the velocity of the exhausted air, measured by Cassell's anemometer, was 682 feet per minute.

For ventilating short drifts or crosscuts small ventilating fans of 18 inches diameter and 8-inch face are used, driven by a 6-foot wheel moved by hand power. Boys are employed for this purpose. The air is carried to the face of the drift by 8-inch sheet-iron pipes.

DRAINAGE.

The water from all underground workings below the 800 level is conducted to the Buena Vista shaft, where it is pumped to the adit or drain tunnel, and through this tunnel reaches the surface. The amount of water raised is small when the large area of the underground workings is taken into consideration. The part of the mine controlled by the Randol shaft, from the 800 level down to the 1,800 level, is almost dry, and the small quantity of water which collects in the sump is pumped out once a week by a hand pump and the water conducted in a pipe through the 1,800-foot level toward a winze which connects with the Buena Vista shaft. The workings above the 800 level are drained by the Day tunnel and the Randol crosscut. From the Washington shaft the water is drained by a siphon down the incline from the 1,100-foot level into the 1,400 crosscut of the Santa Isabel shaft. From the 1,400 station of the Santa Isabel shaft the water is carried by an inverted siphon, made of a 4-inch pipe, down the shaft to the 2,100-foot level, and along that level to the Buena Vista shaft, and up to a tank 193 feet below the adit tunnel, and thence raised by the pump. The water from the lower workings of the Santa Isabel shaft drains into the Buena Vista shaft, and with the water from other parts of the Buena Vista workings is pumped to the surface. The Saint George shaft drains into the Santa Isabel workings. The Almaden shaft is drained by hoisting the water in buckets.

Buena Vista pumping engine.—The pumping engine at the Buena Vista shaft is of the compound direct-acting rotative type. The cylinders are placed directly over the main beam or bob, and in line with it. The initial cylinder piston is connected by means of rods, and slides to the pin nearest the fly wheel, the expansion cylinder piston being connected to the beam in the same manner, between the initial cylinder and the beam trunnions. The total lift is 890 feet, including the sump. The pump work in the shaft is on the Cornish system, and consists of 8 plunger pumps, 2 of which are placed at each of the 4 stations, with a single spear passing between them. In addition to these pumps is the one stationed 193 feet below the adit tunnel. The water comes to this pump from the 1,400 level of the Santa Isabel shaft through a 4-inch pipe 3,000 feet long and discharges 75 gallons per minute into the supply tank.

The pump stations are 10 by 18 feet in size, and situated at distances varying from 205 to 237 feet perpendicularly above each other. The tanks on these stations have each a capacity of 2,400 gallons. The pump stations are at 499 (193 below adit), 543, 743, 971, and 1,171 feet below collar of shaft. The bob stations are 384, 634, and 1,062 feet below collar. Each pump discharges through an 8-inch column into station above. The column is made of 8-inch lap-welded wrought-iron tube, joined at the ends by cast-iron flanges fitted on the tube and secured by expanding it to fill the bore of the flange tightly and in a manner to prevent telescoping. The spear, or pump rod, is of Oregon pine, 1,160 feet long, in sections of 50 feet. The first 600 feet of this rod are 12 by 12 inches in section, the remainder being 10 by 10 inches. The joining of the sections is effected by butting the ends evenly and closely together and securing them in position by placing wrought-iron strapping plates 20 feet long, 8 inches wide, and 1 inch thick on each of the 4 sides of the rod, the joint being in the middle of their length, and bolting through rods and straps with 40 1-inch bolts, one-half passing the other at right angles. The pump plungers are connected to pump rod by cast-iron brackets securely bolted to 2 opposite sides of the rod and engaging with flanges on the ends of the plungers. To provide against lateral motion of the rods they are stayed at each 50 feet of their length by inclosing them in wooden guides, the rod at such places being lined with oak boards secured by iron clamps. The balance bobs are 3 in number, made of cast iron, with wrought-iron tension straps. They are each connected to the pump rod by wrought-iron links or connecting rods 15 feet in length, with brass journal boxes and straps on each end. They are hung from 2 wrought-iron pins in nose of the bob, the lower end engaging with pins in 2 cast-iron brackets bolted to 2 opposite sides of the pump rod. The bob stations are 30 feet long, 12 feet wide, and 18 feet high, secured by 14 by 14 inch timbers; so also are the pump stations. The first is 383 feet from the surface, the second 250 below the first, and the third 428 feet below the second. A 9-inch lift pump is used to raise water from the sump to the plunger pumps on the 2,100-foot level, the difference in capacity between the 2 8-inch pumps and the lift pump being supplied by the flow of water in the 2,100 level, which also receives any excess over 75 gallons per minute from 1,400 level at Santa Isabel shaft.

The pumps described raise 315 gallons per minute, making 8 double strokes in that time. It would be 360 gallons per minute if the supply pipe to pump taking water from 1,400 Santa Isabel shaft was large enough to admit of a supply of 120 gallons per minute, which is the amount required to supply that pump at 8 strokes per minute. The stroke of the pump is 6 feet.

The pump rod is actuated, as already mentioned, by an under-beam compound condensing steam engine with Scott & O'Neil balanced puppet valve and cut-off motion. The cylinders are placed side by side on a heavy bed plate, and to the bottom of this are bolted the guide plates for the crossheads. The cylinder of the high-pressure engine is 21 inches in diameter and has a stroke of 96 inches. The expansion cylinder is 47 inches in diameter, stroke 70 inches. The connecting rods of each engine are connected directly to one end of the beam and pump rod to the other end. The initial engine, being on the outside, has a longer stroke and greater piston speed than the expansion engine, which is placed nearer the center of the beam. The beam is made of cast iron, the arms of which are securely tied by wrought-iron straps 10 by 2 inches in section. The main connecting rod connects an angle arm of the beam to a wrought-iron crank and shaft, on which is placed a fly wheel 24 feet in diameter, weighing 50,000 pounds. The valve motion is derived from a shaft running at right angles to the crank shaft and operated by a miter wheel.

The air pump and condenser are of a special kind on account of the small quantity of water available. The condensation water falls from the condenser through an 8-inch pipe to a tank placed 35 feet below it. The end of the pipe is 3 feet below the water surface in the tank, sealing it against the atmosphere. A small independent bucket-and-plunger pump maintains the vacuum in condenser. The condensation water flows from the tank receiving it through a flume 1,850 feet long and 2 feet wide, passing in its circuit through a pond 25 by 50 feet, and discharging into a tank a few feet from and about 6 feet lower than the first tank. A pump placed in the shaft at this point raises the water, discharging it into a tank on the surface, when it again passes through the condenser, it having been sufficiently cooled in its circuit through flume and pond, the cooling surface of which is nearly 5,000 square feet. The engine is also provided with an automatic stop, which throws the valves out of connection and instantly stops its motion if through any accident it should be relieved of all or any considerable part of its load.

The foundation is built of hewn sandstone, with cap stones of granite. The pump work is handled, when necessary, by a double-cylinder horizontal geared hoist, set on stone and granite foundation.

The cylinders are 12 inches in diameter, with stroke of 24 inches. The reel and spur wheel are bolted together and keyed on same shaft. The spur wheel is 12 feet 1 inch in diameter, with V-shaped teeth, 3.25-inch pitch, and 12-inch face and gears, with a pinion 2 feet in diameter on crank shaft of engine. The reel is 3 feet in diameter, and constructed for winding flat rope. The engine is fitted with a closed link and reversing lever, Corliss throttle valves, and a powerful Eckhardt stand brake, applied on engine fly wheel. The rope used is flat crucible steel wire rope 4.5 by 0.5 inch, 2,000 feet of which can be wound on the reel if desired. The rope in use is about 1,600 feet long.

Santa Isabel pumping works.—The pumping plant at Santa Isabel shaft consists of 6 6.5-inch plunger pumps and 4 6-inch pumps, all having a stroke of 5 feet.

Of the 6.5-inch pumps 2 are placed at the 1,700, 1,400, and 1,000 foot levels; of the 6-inch pumps 2 are placed at the 1,900 and 2,000 foot levels. They are actuated by 2 pine rods 6 by 8 inches in section, 1,230 feet long, in 50-foot sections, and connected in the same manner as those at Buena Vista shaft. They are connected to 2 right-angle bobs on the surface, arranged so that one rod is ascending while the other is descending. In this way one rod balances the other, and as the water flows through the column on both up and down stroke, 1 discharge column only for the 2 pumps is required. There is 1 balance bob attached to each rod to relieve the surface bobs of some of the weight of the pump rods. The column is made of 6-inch lap-welded wrought-iron tube, connected by threaded ends and screwed into connecting sleeves. Part of the column, however, is connected by cast-iron flanges.

This pump work is operated by a compound condensing engine, the high-pressure cylinder being within and concentric with the low-pressure cylinder, the piston of which is an annular ring 42 inches in diameter outside and 26 inches inside. The high-pressure cylinder is steam jacketed, 19 inches in diameter, with stroke of 5 feet. The steam distribution is effected by a double-ported slide valve controlled by Davey differential valve gear. The air pump is driven by an extension of the high-pressure piston rod. It is 9 inches in diameter, 5-foot stroke, and is situated directly behind the steam cylinders. The engine frame is extended to connect with sole plates carrying the bobs operating the pump rods. They are of cast iron, with tension straps of wrought iron. The pit work is handled, when required, by a capstan situated near the shaft house.

A third pumping plant, not now erected, consists of a horizontal noncondensing engine, having on the crank shaft a pinion gearing with a spur wheel, on the shaft of which is keyed a disk with wrist pin. The disk has in its face 4 holes at varying distances from its center, into any one of which the wrist pin may be put, giving a stroke varying from 2.5 to 4.5 feet. This wrist pin is connected by a wooden connecting rod strapped with iron to an angle bob to which pump rod is attached. The bob is constructed of wood, with iron straps, and fitted with a balance box, wherein weights may be placed to equalize load on the engine. The gear wheels are 2.375-inch pitch and 9-inch face; ratio between pinion and spur wheel as 1 to 7.

The pumps in the shaft are to have 6-inch plungers, the stroke varying with the position of the wrist pin in the disk or crank plate operating the angle bob. The spear rod is 6 inches square, to which the plungers are secured in a different manner from those described at the Buena Vista shaft.

The plunger is of iron, cast hollow, and about 1 inch in thickness. A suitable piece of timber, considerably longer than the plunger, is made to fit tightly inside of the hollow tube, and after being driven in is tightly wedged in place. The timber projecting beyond the plunger is square in section and clamped to the pump rod, a distance piece being introduced between them to bring the plunger to the desired distance from the rod. There are 2 plunger pumps and 1 lift pump still remaining as part of the pit work, operated by the machinery just described, the capacity of which is 50 to 60 gallons per minute from a depth of 1,000 feet; speed in shaft, from 3 to 12 strokes per minute.

The Santa Isabel pumps will discharge 170 gallons per minute from a depth of 1,500 feet; speed in the shaft, from 1 to 10 strokes per minute.

The Buena Vista pumps will discharge 315 gallons per minute from a depth of 1,800 feet; speed, from 2.5 to 8 strokes per minute. The average speed at Buena Vista pump works at present is about 4 strokes per minute.

In addition to the regular pumping machinery there are available for mine drainage 4 steam pumps, 2 of which are of a capacity of 80 gallons per minute, 1 of 40 gallons, and 1 of 50 gallons capacity; also 2 bailing tanks, holding 500 gallons each, and 2 other tanks, each carrying 120 gallons.

HOISTING WORKS.

Buena Vista shaft.—The hoisting machinery at the Buena Vista shaft consists of 2 horizontal noncondensing engines, with balanced puppet valves with O'Neil cut-off motion, reversing link, and Corliss throttle valves.

The engines are connected by and act on the same crank shaft. 2 reels, to which brake wheels, 10 feet in diameter and 8-inch face, are attached, are placed on the crank shaft, and are free to revolve in either direction and independent of each other. They may be made to revolve with the shaft by throwing into gear 2 clutches sliding on the shaft (it being square in section at these places) and revolving with it. The reels may be used singly or together, and by winding the ropes on the reels in opposite directions one may be made to hoist while the other lowers, using the descending cage and rope as a counterweight. Flat steel wire rope is used, 3.5 inches wide and three-eighths of an inch thick. The length is 1,600 feet. Each reel is provided with a powerful Eckhardt brake, operated by the foot. An iron brake strap lined with wood is also employed, acting on the crank disks, which are 8 feet 10 inches in diameter and 6-inch face. This brake acts on the engine, or either reel or both, if the clutches on the shaft are engaged with them.

A Behr spiral indicator shows position of cages in the shaft. This indicator consists of a drum 39 inches in diameter, 4 feet 6 inches long, revolving with its axis vertical behind a pointer, to which a vertical motion of 2.375 inches for each revolution of the drum is communicated by an upright screw, revolving by the side of the drum. The vertical motion of the pointer, combined with the circular motion of the drum, traces a spiral line on its surface, the length of which is about one-tenth of the depth of the shaft. On this line are placed brass plates showing the different stations and the number of bells constituting the signals for the stations.

A second pointer, moving against a stationary index board, is also provided. This is always in the engineer's sight and lessens the liability of his confusion by reason of the revolving drum carrying the station marks out of his sight during the greater part of its revolution.

These indicators are driven by gear wheels, one on each reel and in permanent connection with it. The 2 reels are set opposite the 2 hoisting compartments in the shaft and are situated 50 feet 6 inches from it. On the platform from which the engine is handled there are 5 levers, 1 for throttle valves, 1 for reversing the engine, 1 for adjusting the cut-off, and 2 for operating clutches. The 3 pedals for operating the brakes are side by side, and they, with the first 3 levers, are within reach of the engineer without changing his position. The foundation is built of sandstone, with granite cap stones. The gallows frame consists of 2 perpendicular frames of 18-inch timbers, 1 at each end of the shaft, 45 feet high, standing on sills 55 feet long. The frame is 18 feet wide, from outside to outside, and stiffened by horizontal beams and braces. Each frame is secured against the thrust by inclined beams 16 by 20 inches thick, and 50 feet 9 inches long. The 2 frames stand 32 feet 6 inches apart, from outside to outside, and are connected by bridged trusses of 18-inch square timbers, supported by struts 12 by 18 inches. The horizontal beams on top and crossing from one frame to the other are 18 by 24 inches. The sheaves are carried on 14-inch timbers, 2 on top of each other at each side of the sheaves.

The overhead pulleys or sheaves are 9 feet in diameter (center 48 feet above floor), with rims of cast iron and wrought-iron arms. The speed of hoisting is from 1,000 to 1,200 feet per minute in the shaft. The load, including 1,000 feet of rope, is 9,000 pounds.

Each compartment of the shaft has a separate bell for signaling. The bell cord is of three-eighths inch galvanized twisted iron-wire rope, and can be reached from the cage in any position in the shaft.

The boilers at this shaft are 6 in number, set in pairs over 1 furnace. They are each 54 inches in diameter and 16 feet long, with 46 3.5-inch tubes. Each pair is connected by 1 mud drum and 2 steam drums. A 6-inch safety valve is placed on each steam drum, 2 of which are also fitted with Crosby adjustable safety pop valves. The main steam pipe is 10 inches in diameter, with 6-inch branches to the hoisting engine and pumping engine.

SANTA ISABEL SHAFT.—The hoisting machinery at Santa Isabel shaft is a single horizontal high-pressure engine, cylinder 16 inches in diameter, stroke 36 inches, with balanced slide valve and reversing link.

On the crank shaft are 2 pinions, free to revolve on it, and 2 clutches revolving with it, the latter sliding on 2 feathers to engage with either or both of the pinions. There are 2 reels, 1 for each hoisting compartment in the shaft, each 10 feet in diameter and 20 inches wide, having a spur wheel and brake rim cast on one side, the spur wheels gearing with pinions on the shaft. The wheels are 11 feet in diameter, pitch of teeth 3 inches, and 8-inch face. Ratio of wheel to pinion is as 4.5 to 1. Round steel-wire ropes 1.125 inches in diameter are wound on the 2 reels, and in opposite directions to admit of hoisting with balanced load. 2 dial indicators show position of cage in the shaft, the index pointer traveling about 10 inches for every 100 feet traveled by the cage in the shaft. Each reel is provided with a stand brake, the shoes of which are lined with sugar pine. A powerful iron band brake is also applied on the engine fly wheel. The 3 brakes are operated by the foot and one of them is so arranged that hydraulic power can be applied to it. The one last referred to is on the reel working opposite the middle compartment in the shaft, it being the one used when sinking is done in the shaft. The gallows frame is 32 feet in height, built of 14 by 14 inch timber in the form of a truncated pyramid 30 feet square at the base and 18 by 15 feet at the top. Overhead pulleys are 9.5 feet in diameter, the rim grooved for rope of 3.5 inches in circumference.

The machinery is set in a massive foundation of artificial stone, the center of reels being 48 feet from the shaft. The boilers are 4 in number, set in pairs, 2 having separate furnaces and 2 being set over one furnace. The latter are connected by 1 mud drum and 1 steam drum, the former by 1 mud drum, but having separate steam drums. Of this pair, each is 56 inches in diameter and 16 feet long, with 48 3.5-inch tubes. The other pair is built of steel, each 54 inches in diameter, 16 feet long, and having 46 3.5-inch tubes. A 4-inch safety valve is fitted to each steam drum. The boiler feed water is heated by exhaust steam to the boiling point before entering the boiler.

The hoisting speed at this shaft is from 600 to 800 feet per minute. The load, including 1,000 feet of rope, is about 6,700 pounds.

RANDOL SHAFT.—The hoisting gear at the Randol shaft consists of a high-pressure horizontal engine, cylinder 16.5 inches in diameter, the stroke being 30 inches.

1 reel, 9 feet in diameter, 25-inch face, is keyed on the spur-wheel shaft, the spur wheel being driven by a pinion on the crank shaft. These wheels have V-shaped teeth, 3-inch pitch and 10-inch face, ratio about 4.5 to 1.

The pointer on the indicator has a vertical motion of 3.25 inches to 100 feet in the shaft, the direction of its motion being the same as that of the cage in the shaft. It is operated by a vertical screw driven by bevel gears, which derive their motion from reel shaft. The reel is fitted with a stand brake, which is applied by releasing a weight acting on a lever, drawing the brake block together and against the reel. A foot brake is also applied to the fly wheel of the engine.

The speed of hoisting is from 500 to 600 feet per minute. The load is the same as at the Santa Isabel shaft. A round steel-wire rope is used, 3.5 inches in circumference (1.125 inches in diameter). The gallows frame is 28 feet high, built of 12 by 12 inch timber, of the truncated pyramid style, 24 feet square at the base and 11 feet at the top. The overhead pulley is 8.5 feet in diameter.

3 boilers set singly furnish steam for this engine, 2 of which are used at one time: 1 56 inches by 16 feet, with 48 3.5-inch tubes; 1 52 inches by 16 feet, with 54 3-inch tubes; 1 54 inches by 16 feet, with 46 3.5-inch tubes. Each boiler has 1 steam drum, 2 have 4-inch safety valves and 1 a 5-inch safety valve. The feed water for boilers passes through a heater, through which exhaust steam passes, and is raised to a temperature of over 200°.

The record of hoisting at the Randol shaft gives the number of skip loads of rock and ore during the last 4 years as follows:

1886	37,371
1887	40,862
1888	41,791
1889	45,934

In 1889 the average number of skip loads hoisted each working day was 184, or 276 tons, exclusive of the number of trips made with men, timber, etc.

WASHINGTON SHAFT.—The hoisting machinery at the Washington shaft has 2 reels, 6 feet 6 inches in diameter, 24-inch face, one opposite each of the 2 hoisting compartments in the shaft. They are both placed on the same shaft, one being free to revolve and the other keyed. The latter is in permanent connection with the engine, connecting spur wheel and pinion being in a ratio of about 5.5 to 1, the teeth 2.375-inch pitch, 6-inch face. The former is made to revolve with the reel shaft by throwing into gear a clutch sliding upon 2 feathers and revolving with it. Round steel-wire rope 3.5 inches in circumference is used and wound on the reels, 1 passing over and 1 passing under. The reels are driven by a pinion on the crank shaft of a horizontal slide-valve engine, 12-inch cylinder with 24-inch stroke. A speed of 400 feet per minute in the shaft is attained. The load, when skip is at the bottom of the shaft, is 4,500 pounds. The indicator is the same as that at the Randol shaft. This machinery is situated 60 feet from the shaft and set on a foundation of timber. There are 2 boilers, each 56 inches in diameter, 16 feet long, with 48 3.5-inch tubes.

The gallows frame consists of 2 perpendicular upright beams 16 by 20 inches in section, 43 feet 4 inches high, standing on 16 by 18 inch sills 56 feet long, and braced in the line of thrust by inclined beams 16 by 18 inches, 56 feet long. The 2 uprights, 1 at each side of the shaft, stand 20 feet apart and are trussed at the height of 28 feet by a horizontal timber 18 by 20 inches, supported by short braces or struts of 9 by 20 inches. Across the tops of the uprights and connecting both is another horizontal beam 18 by 20 inches. Perpendicular posts 12 by 20 inches are framed between the 2 horizontal beams and carry the sheaves, the shafts of which are 35 feet 6 inches above the floor of the shaft house. The sheaves are 8.5 feet in diameter.

The 2 hoisting machines for prospect shafts as used at the Almaden and Saint George (now at San Francisco) have each 2 steam cylinders 6 inches in diameter, with a stroke of 12 inches. A reel, supported by brackets cast on engine frames, is fitted to each. They are 20 inches in diameter, 10.5-inch face. A spur gear is cast on the side and is driven by a pinion on crank shaft of the engine. The ratio is 4 to 1; pitch of teeth, 1.5 inches, 3.5-inch face. The load, including 500 feet of wire rope five-eighths of an inch in diameter, is 2,000 pounds, and is raised at a speed of 300 feet per minute. A foot brake is applied on the reel.

The upright boilers supplying steam to these engines are 42 inches in diameter and 8 feet high, each having 99 2-inch tubes. They stand on cast-iron base plates 10 inches high, forming the ash pit, and have brackets carrying the boiler feed pumps. Each boiler has a steam drum and a 2-inch safety valve.

The gallows frames are of the truncated pyramid style, overhead pulleys 36 inches in diameter.

THE ENGINEERS.

The engineers at the several shafts work in 2 shifts of 12 hours each. The cages or skips are put in motion in answer to the signals given by gongs that are connected with the different stations of the shafts by wire rope made of galvanized coarse iron wire, twisted, three-eighths inch diameter, and attached at each station to an iron lever. The general signals are: 1 bell for "hoist" or "stop"; 2 bells for "lower down". Other signals are agreed upon as circumstances require. The engineers attend to the brakes. Where 2 reels are employed, hoisting with balanced cages or skips is invariably the rule, and with single reels when lowering the skip the engine is reversed and the speed of the descent is regulated partly by means of the fly-wheel brake and partly by putting the reversing link in position for hoisting, the throttle valve of course being closed.

When raising or lowering men 1 cage only is used, the other reel, if there are 2, being then held by the reel brake. The speed of the cage in the shaft is then from 300 to 400 feet per minute, and its descent is regulated in the same manner as in the single-reel hoist, by fly-wheel brake and reverse bar, the operating reel being invariably in connection with engine when men are in the shaft.

The boilers are cleaned regularly at intervals of from 2 to 4 weeks, according to the amount and kind of water used. The water is supplied from 3 sources, one of which supplies a limited amount of very pure water, that forms little or no scale in the boilers in which it is used. The water obtained from the other sources forms a very hard scale, which necessitates the use of boiler-cleaning compounds, besides a liberal use of the scaling hammer, to keep the boilers in good condition. Every boiler has a manhole in front, below the tubes, through which access is gained to the sheets immediately over the furnace, which are thus kept thoroughly clean. The vertical tubular boilers, being inaccessible on the inside, require to have the tubes removed about every 2 years, when they are thoroughly cleaned and the tubes replaced.

HORSE WHIMS AND WINDLASSES.

For prospect shafts there are also, for hoisting, 2 horse whims. The reel is 7 feet diameter, 10-inch face, and revolves on a 3-inch shaft with vertical axis. The sweep rod can be thrown in or out of gear at will, as the bucket is required to ascend or descend. An iron strap brake is applied to regulate the descent of the bucket, the sweep rod being then out of gear. A half-inch steel wire rope is used. The load is about 300 pounds, and moves through the shaft at about 70 feet per minute.

The windlasses used for prospect work have a wooden reel 6 inches in diameter and 4 feet long, with wrought-iron crank handles inserted in the ends, which are strengthened by iron rings being driven on them, the axles being formed by a part of the crank handles projecting from the ends of the reel in a direction parallel with its axis. 2 upright pieces, generally of 1.5 by 12 inch pine board set in a mortise cut in a 6 by 6 inch cross-timber, support the reel, and are connected by a plank, the ends of which rest upon and are spiked to the upright pieces. On the top of this board is a wooden bar, sliding in guides, which is drawn out far enough to catch the handles and prevent the reel from revolving when it is required to hold the bucket and keep it in position desired. When lowering the bucket a brake is applied on the reel, and consists of a rope, one end of which is made fast to the crosspiece and a turn taken around the reel in the direction of its motion when lowering. The loose end is then drawn tight, as may be required to command the descent of the bucket. 2 buckets are sometimes used, the rope having a number of turns on the reel, with 2 free ends. To these ends the buckets are attached and assist in balancing each other. As the depth of the shaft increases a turn is taken off the reel, adding to the length of the free ends. The load is about 100 pounds. 3-inch hemp rope is used. 100 feet can be sunk in this way.

AIR COMPRESSORS.

To supply compressed air for operating machine drills, pumps, and other machinery in the mine there are 2 air compressors erected in the Santa Isabel shaft house: 1 Burleigh air compressor, with steam cylinder of 18 inches diameter and 24-inch stroke, the air cylinder of 24 inches diameter and 20-inch stroke, discharging into receiver 54 inches in diameter, 12 feet 6 inches high; 1 Clayton air compressor, with 2 steam cylinders, each 14 inches in diameter, and 2 air cylinders of 12 inches diameter, all of 9 inches stroke. The air cylinders are double acting. The receiver is 36 inches in diameter and 9 feet long. Another Burleigh air compressor, with steam cylinder of 15 inches diameter and 18 inches stroke, and air cylinder of 15 inches diameter and 15 inches stroke, discharging into an air receiver 48 inches in diameter, 10 feet 6 inches high, is on hand, having been in use at the Washington and Buena Vista shafts.

MACHINE DRILLS.

The rock drills, 11 in number, are as follows: 2 3.5-inch Ingersoll Eclipse drills, 1 3.5-inch Ingersoll tappet drill, 4 3-inch Ingersoll Eclipse drills, 1 3-inch Ingersoll tappet drill, 2 3-inch National drills, and 1 2.5-inch Ingersoll tappet drill.

VENTILATION.

For ventilation there is 1 Baker blower of a capacity of 1,500 cubic feet per minute, and 1 Baker of a capacity of 1,000 cubic feet; 1 Root blower, capacity 800 cubic feet per minute, and 1 48-inch Blackmann exhaust ventilator.

SHAFT HOUSES.

BUENA VISTA SHAFT.—The shaft house at Buena Vista contains hoisting-engine room, 45 feet wide and 100 feet long; pump-engine room, 45 by 45 feet; boiler room, 45 by 55 feet, the whole forming a rectangular frame building 90 feet wide and 100 feet in length. Fire protection is afforded by 4 hydrants (2-inch), fed by a supply tank containing 15,000 gallons. The pressure of water is 70 pounds per square inch. Adjoining the boiler room there is an excavation in which 700 tons of coal can be stored. Situated near the shaft house is the blacksmith shop, 46 by 26 feet, a part of which, 18 by 12 feet, is inclosed and used as a drying and changing room for the miners.

SANTA ISABEL SHAFT.—The Santa Isabel engine house is 90 by 40 feet. Connecting with it at right angles is the boiler room, 60 by 40 feet. Adjoining the main building is the miners' changing room, 21 by 12 feet in extent. The blacksmith shop, about 100 feet from shaft house, is 40 by 20 feet in dimensions. 4 2-inch hydrants are placed around the building, having a water pressure of 50 pounds per square inch. Supply tank contains 15,000 gallons. The shed provided for coal storage will hold 400 tons.

RANDOL SHAFT.—The works at the Randol shaft are contained in an irregular building, whose greatest length is 80 feet and greatest width 50 feet, the boiler room being 40 by 32 feet. The changing and drying room for the use of the miners, 19 by 18 feet, is provided with 2 steam heaters. Placed adjacent to the shaft house are the carpenter, blacksmith, and machine shops. The carpenter shop is 24 by 40 feet in size. The blacksmith shop is 25 by 50 feet, and has 4 forges. Blast is supplied by a No. 3 Anderton blower. All of the forges are worked by day, and 1 by night. The drills dressed average about 1,000 every day at this shop. The kind of steel used for drills is 1-inch octagon black diamond. The machine shop adjoins the blacksmith shop, and is 16 by 35 feet in size. It contains 1 Putnam lathe, 12-inch centers; 1 power drilling machine, 1 Wiley & Russell bolt-cutting machine, 1 milling machine, and 1 hand-power drilling machine. These machine tools are driven by a 6 by 16 inch steam engine, and are used in making and repairing cages, skips, cars, tanks, etc., and in repairing the machinery at the different shafts. 2 2-inch hydrants, with 35 pounds water pressure, supply protection against fire. 600 tons of coal can be stored at this shaft.

WASHINGTON SHAFT.—The engine house at the Washington shaft is 99 by 32 feet, the adjoining boiler room being 40 by 32 feet. 300 tons of coal can be stored at this shaft. The blacksmith shop and carpenter shop are near the main building, the former being 25 by 40 feet in extent, having 2 forges. The carpenter shop is 32 by 60 feet. 1 2-inch hydrant is provided for fire protection. To the hydrant is attached 50 feet of 2-inch hose, and all other hydrants at the shaft houses are similarly provided. The changing room is 12 by 20 feet.

THE ALMADEN engine house is 34 by 78 feet, the boiler room 24 by 36 feet, which also contains the blacksmith shop.

THE SAN FRANCISCO shaft house is 20 by 54 feet; height of gallows frame is 16 feet, 14 feet spread at the bottom and 8.5 feet at the top.

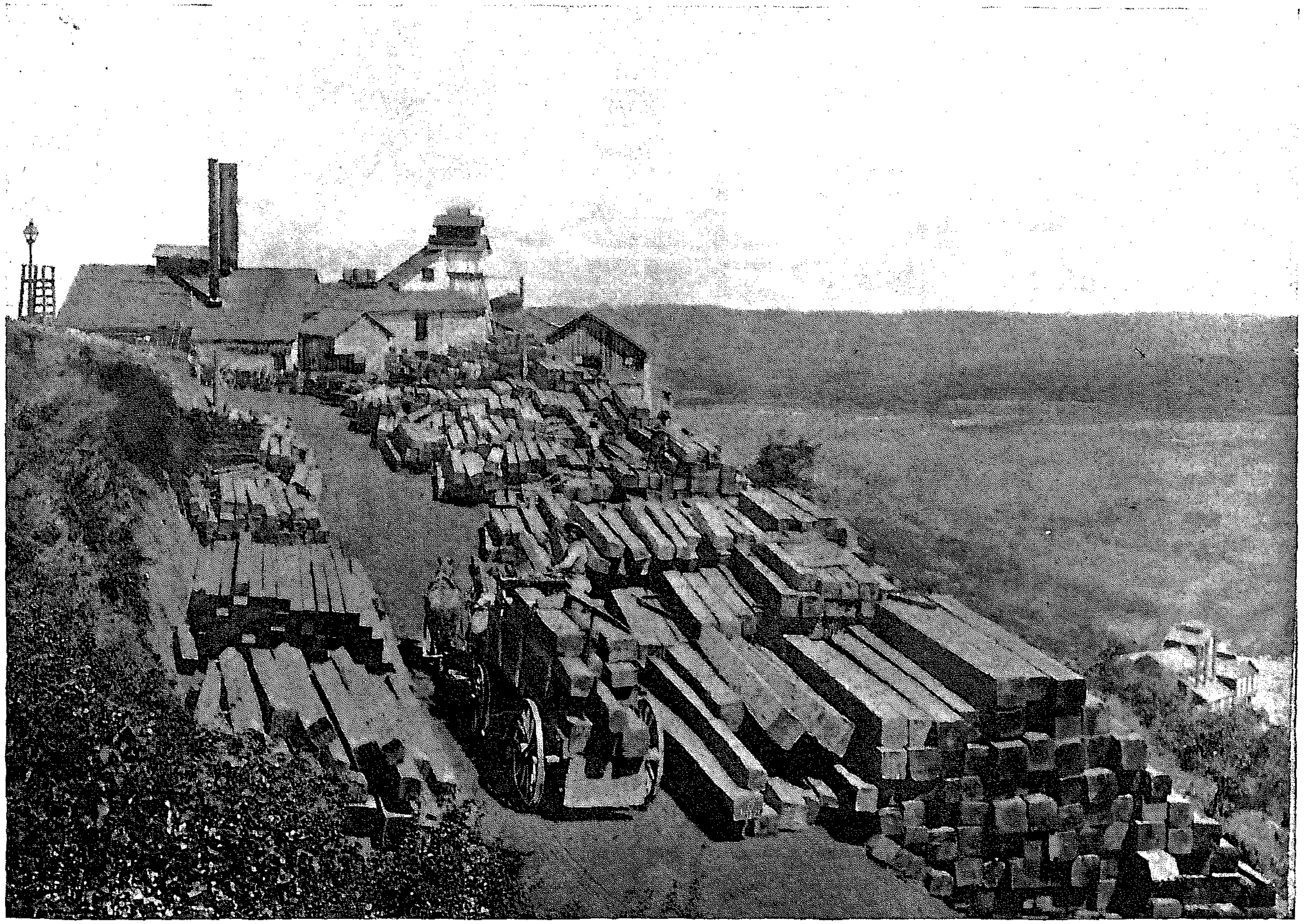
LIST OF ENGINES, ETC., AT NEW ALMADEN.

HOISTING ENGINES.

LOCATION.	GEARED.				DIRECT ACTING—2 CYLINDERS.		
	Single cylinder.	Double cylinder.	Diameter of cylinder. (Inches.)	Stroke. (Inches.)	Number of engines.	Diameter of cylinder. (Inches.)	Stroke. (Inches.)
Randol shaft	1	....	16.5	30	....	....	....
Santa Isabel shaft	1	....	16.0	36	....	....	....
Buena Vista shaft	....	1	12.0	24	1	16	60
Washington shaft	1	....	12.0	24	....	....	....
Saint George shaft	....	1	6.0	12	....	....	....
Almaden shaft	....	1	6.0	12	....	....	....

STEAM PUMPS.

LOCATION.	DOW.		KNOWLES.		WORTHINGTON.		CAMERON.		STODDARD.
	No. 4.	No. 6.	No. 5.	No. 0.	No. 1.	No. 2.	No. 0.	No. 5.	No. 5.
Randol shaft	1	....	....	....	....	1	....	....	....
Santa Isabel shaft	....	....	....	1	....	....	....	....	1
Buena Vista shaft	....	....	....	2	....	....	....	....	....
Washington shaft	....	....	....	....	1	....	....	1	....
Saint George shaft	....	....	....	....	....	....	1	....	....
Hacienda	....	....	....	1	....	....	1	....	....
In storeroom	1	2	....	....	....	....	....	1	....



RANDOL SHAFT, NEW ALMADEN, CALIFORNIA, IN 1889.

LIST OF ENGINES, ETC., AT NEW ALMADEN—Continued.

ENGINES FOR GENERAL SERVICE.

LOCATION.	Horizontal. Number of engines.	Horizontal. Diameter of cylinder. (Inches.)	Horizontal. Stroke. (Inches.)	Vertical. Number of engines.	Vertical. Diameter of cylinder. (Inches.)	Vertical. Stroke. (Inches.)
Randol shaft	1	6	16			
Buena Vista shaft				1	6	8
Almaden shaft				1	6	7
Hacienda	1	8	16	2	6	7
In storeroom	1	6	12	1	6	7

AIR COMPRESSORS.

LOCATION.	Burleigh. No. 3.	Burleigh. No. 7.	Clayton duplex. No. 3.
Santa Isabel shaft		1	1
Washington shaft	1		

PUMPING ENGINES.

LOCATION.	Geared. Number of engines.	Geared. Diameter of cylinder. (Inches.)	Geared. Stroke. (Inches.)	Compound condensing, direct acting. Number of engines.	High-pressure cylinder. Diameter (Inches.)	High-pressure cylinder. Stroke. (Inches.)	Low-pressure cylinder. Diameter (Inches.)	Low-pressure cylinder. Stroke. (Inches.)
Santa Isabel shaft				1	19	60	26 / 42	60
Buena Vista shaft				1	21	96	47	70
Washington shaft	1	10	20					

MACHINERY AT HACIENDA.

The machine shop at the hacienda contains 1 screw-cutting lathe with 9.5-inch centers, 1 flask-tapping and threading machine, 1 Wiley & Russell bolt cutter, and 1 power drilling machine.

The engine house contains 2 horizontal tubular boilers: 1 of 50 inches diameter, 15 feet long, with 40 3.5-inch tubes, and 1 of 30 inches diameter, 11.5 feet long, with 19 3-inch tubes; 1 Knowles steam pump, No. 7; and 1 horizontal steam engine, with 1 cylinder of 8 inches diameter and 16-inch stroke, driving soot machine, also set up in the engine house.

DESCRIPTION OF TOOLS.

The hammer is a piece of steel, weighing from 7 to 8 pounds. It has 2 striking faces or polls, the eye in the center being 1.25 inches in diameter, into which the helve or handle, about 2.5 feet long, made of ash or hickory, is fastened.

The drills are octagonal bars of cast steel, about 1 inch thick, cut in lengths of 1.5 to 4 feet. One end is flattened out wedge-shaped and drawn to 1.125 or 1.25 inches in width.

The scraper is a three-eighths-inch bar of round iron, 3.5 to 4 feet long, on one end of which a hemispherical spoon is hammered out at right angles to the axis of the bar, while the other end has a half-cylindrical spoon about 6 inches long, which is used in charging drill holes with black powder when their direction is horizontal or slightly upcast.

The swab stick is a piece of round wood three-fourths of an inch in diameter and 3 or 4 feet long. One end is bruised into the shape of a brush, to which the sludge from the drilling adheres and is drawn from the drill hole.

The "gad" is a piece of drill steel 6 inches long made into the form of a wedge. It is used to wedge off fragments of rock, or for breaking ground which does not require blasting.

The "moyle" is a bar of drill steel from 1 to 2 feet long with 4-sided point. It is used like the gad, and is especially employed in cutting the so-called "hitches" for timbers.

The pick is made of a square bar of iron 1.5 inches thick and slightly curved in the plane of the handle. It has a 4-sided pyramidal steel point at the curved end, and a poll 3 inches long at the other end. It has an eye like the hammer 3 inches from the face of the poll, into which the ash or hickory handle, about 2.5 feet long, is inserted and secured.

The shovel is the ordinary long or short handled square or round-pointed shovel. They are bought with the helves fitted to them.

These constitute the regular kit of tools with which the miners are provided by the mining company. Broken pick handles or hammer handles are replaced by the miner who uses the tool.

The wheelbarrow is used in some of the prospect drifts, where a regular track for tramming has not been laid. The wheelbarrow used in mining is made of wood, and is of the old Cornish type called the "Jack" wheelbarrow.

The timbermen use axes, crosscut saws, handsaws, augers, chisels, sledges, block and tackle, and ropes, furnished them when needed.

EXPLOSIVES.

Black and dynamite powders are stored in the company's powder magazine, a solid brick building, well protected and standing isolated at a safe distance from the Randol shaft. The percussion caps and fuse are kept apart in the company's storehouse. The black powder used is the size F from the Santa Cruz powder mills, and the other powder is dynamite No. 2. The explosives used in the footage labores are under the charge of the blaster, who receives at one time from 25 to 30 kegs (of 25 pounds each) of black powder and about 100 pounds of dynamite powder from the magazine and stores them in an underground magazine built in an abandoned labor or situated at a safe distance from the workings. About 100 to 200 feet of fuse only are taken into the mine at one time, so as to prevent its getting damp from exposure to the atmosphere underground. The blaster keeps in his magazine, which is under lock and key, also all the tools used by the timbermen working in the labor. The contractors working under the tribute system for ore, or having contracts for drifting or sinking or other prospect work, store their explosives in a safe place at a distance from their work. The dynamite powder for ordinary drill holes is bought in sticks about 8 inches long and 1 inch in diameter. For machine drills the sticks are 8 inches long and 1.5 inches in diameter.

To charge a hole with dynamite powder a fuse of the required length is first prepared, one end of which is shaped to go into the cavity of the cap. The cartridge is then put into the drill hole and pressed tightly in place with the swab stick. It is often found convenient to break the stick of powder into halves before placing it in the hole, for the reason that it will more readily expand when pressed down by the swab stick and more completely fill the drill hole without leaving voids. Sometimes in very hard ground a half or a whole stick more of powder is placed on top of the first one. The fuse with the cap then being placed down on the cartridge, the hole is filled with fine dirt loosely thrown in and slightly tamped, while a wet hole is simply filled with water in place of tamping.

The charging with black powder is done as follows: If the hole is downcast, half of the charge of powder, from 4 to 7 inches of the drill hole, is poured in, the fuse with the cap is inserted, and the other half of the powder charge is poured on top. The hole is then tamped, which consists in packing from 12 to 18 inches of fine dirt on top of the powder by the use of the tamping bar or swab stick. After the hole has been properly tamped a small piece of candle (or snuff) is placed under the outhanging end of the fuse, to be lighted when all holes have been charged and are to be fired. An upcast hole is charged with a cartridge made of powder. These are cylinders made of soaped paper, 1 inch in diameter and from 12 to 18 inches long, filled with powder. The fuse is inserted in the middle, as in charging with loose powder. The object of the paper cylinder is simply to retain the powder, and the paper is soaped so as to keep the powder together. These cartridges are tamped and fired in the same way as with loose powder.

In drilling, the place selected for the hole is started, if possible, with a pick. A man then takes a short drill, and, holding it steadily in both hands in the direction the drill hole is wanted, lets his partner strike the other end in successive strokes with the hammer. After each blow he raises the drill slightly and gives it about one-tenth of a turn. In this way the rock is chipped and a cylindrical hole is formed. Water is poured in the hole if possible, as it is found to expedite the drilling, converting the dust into a wet sludge, in which state it is easily removed from the hole. A rag or washer is put around the drill to prevent the splashing of the water. As the depth of the hole increases a longer drill is used, and by continuing in this way a hole from 4 to 6 feet deep may be drilled. The ordinary drill holes are usually from 1 to 4 feet deep, according to circumstances.

METHOD OF WORK.

Men employed in prospect work labor in gangs as follows: For shaft sinking, usually 9 men, in 3 shifts of 8 hours each, one shift going to work at 7 o'clock in the morning, the next at 3 o'clock in the afternoon, and the third shift at 11 o'clock at night. No time is allowed for regular lunch. For sinking winzes, 6 men, in 2 shifts of 10 hours each, are employed; for raising a winze, 4 men, in 2 shifts of 10 hours each; for drifting, 4 men, in 2 shifts of 10 hours each. These rules are sometimes altered to suit circumstances.

Drifting with machine drills is done by 9 men in 3 shifts of 8 hours each. Most of the drifting and sinking is done by hand drills. Machine drills are only employed in straight tunnels or crosscuts and in the larger shafts when a rapid progress of the work is desirable.

In prospect drifts miners follow the contact of the vein or the footwall with the hanging wall (alta). To do this requires some experience, as the variable nature of the rock makes this distinction at times very difficult. For

TUNNELING AT THE NEW ALMADEN QUICKSILVER MINE.

this purpose the shift bosses and the mining captain visit daily the different parts of the mine where explorations are going on to make sure that no errors are made by the contractors in following the vein.

It is the rule of the company that in drifting, sinking, or raising the contractor has to follow the line of contact between the alta and vein or footwall, one-half of the drift being in either ground, and that should the contact be lost and the breast of the prospect show a decided change to either, running all in alta or all in vein, the contract is considered finished, and new arrangements have to be made as to price before work is continued as directed under the new circumstances.

In crosscuts and inclines or upraises where a certain direction is to be maintained in order to reach a certain point, lines are hung by the surveyor from the roof of the drift to indicate the required course.

The timbering of drifts, shafts, winzes, or crosscuts is done by the contractors in pursuance of their work, and is included in the contract price. The detail part of the work is left entirely to the company of miners (contractors), under the supervision of the shift bosses and the mining captain, and the timber is sent into the mine once a week for this purpose, usually Saturdays. Miners working on footage are paid for the loss of time in transporting the timbers to the labores and in assisting the timbermen, while men working on tribute or by contract do this work without compensation, as it forms a part of their contract. For the underground transportation small 4-wheeled trucks are used. The timbers are stored underground partly in the upper plats of the stations, partly in side drifts that are unused, or at other places on the line and out of the way of the tramming cars.

The system used in the prosecution of the prospect work is called the "yardage system", because the work is paid for by the linear yard in depth or distance excavated. The yardage work is almost entirely done by contract. The several drifts, shafts, winzes, or crosscuts selected by the management of the mine as the future month's work are publicly posted at the company's office on the hill 1 or 2 days previous to the acceptance of the bids, in order to give the miners sufficient time to view the ground and satisfy themselves as to the difficulties and the hazard of the undertaking. The bids are received on raya day (pay day), which falls usually on the last Saturday of every month, and when all bids are received they are compared and, the lowest or most advantageous ones being selected, the awards are made public on the same day. Bids for footage work, tramming, and skip filling are received at the same time.

TIMBERS.

All the timbers used underground are of squared hewn redwood. The thickness varies from 8 to 16 inches, the length from 8 feet to 16 and 20 feet. The lagging is 3, 4, or 6 feet long, and has a thickness of 3 by 6 inches in cross section. Ties for car tracks are 4 by 6 inches in cross section and 4 feet long. Timbers are stored on the surface near each shaft, a year's supply being always kept on hand. Here the timbers are framed for the required work, including timbers for shafts, winzes, and drifts, which are of known sizes, while the timbers for use in the labores are sent into the mine in whole lengths and cut to proper shape underground. The required sizes and numbers are selected and marked with their destination, the shaftman keeping an account of every size and length of timber sent into the mine.

Every Saturday, as already mentioned, is set apart for sending down into the mine timbers that will be required during the coming week. At the Randol and the Santa Isabel shafts cages especially built for the transportation of timbers are employed. The timbers are made to stand up on the platform of the cage, while the upper ends are securely lashed to its frame. The timbers are lifted into this cage by a hand winch, using a 1-inch manilla rope, to which 2 chains are fastened with dogs at their ends, that are driven into the timber. They are brought to the shaft on small trucks, and when at the proper station in the shaft are received there by the men, who unload them from the cage by the dexterous use of rollers, aided by the engineer on the surface by slowly hoisting at the given signal. A regular force of timbermen, from 15 to 20, attend to the general timbering in the mine, as repairing and replacing old or wornout or broken timbers in drifts and labores or winzes, and framing timbers for these purposes on the surface. These timbermen are paid by the month, and have their light furnished.

The timbering of the footage labores is done under the supervision of the blaster (who is in charge of the labor) by the timbermen, assisted by the miners working on footage contract if necessary, for which work they receive day's pay.

The yardage work is measured at the end of the contract, which usually extends to the end of every month, by the mining captain, aided by the surveyor, and in presence of the mining superintendent. The footage work is measured daily before blasting the holes by the blaster or foreman of each labor.

Contracts with tributers are renewed every month by the mining captain and superintendent, who then inspect every tributer's pitch or labor, and agree with the company of tributers on the price to be paid per ton of cleaned ore.

The laborers in the mine are paid by the day and provide their own light. Their work consists in shoveling ore in the footage labores down to the platform, where it is handy for the cars; assisting the timbermen, shaftmen, and pumpmen; filling skips in shafts, and tramming cars where this work is not given out by contract; dumping the cars at the planilla during nighttime, and other services. About 20 men are employed in these occupations, in 2 shifts of 10 men each.

One man, an experienced miner, is employed at each shaft to attend to all work that pertains to it, looking after the pumps, skip roads, station plats, ladder ways, shaft timbers, and general repairs. He is assisted by laborers or timbermen as required. The shaftmen are paid by the month and are furnished with light.

The mining captain is the superintendent of all underground work, which he directs with the aid of the shift bosses. All matters relating to mining are reported to him.

There are 2 shift bosses, alternating, or day and night shifts. They inspect during their shift all work done in the mine by prospectors or tributers, also the laborers, timbermen, trammers, etc., marking down labor shifts and footage work, and reporting the same at the office. They see that the proper force of men is at work everywhere, and in cases of absence that substitutes are provided to insure the regular working at all places.

SURFACE WORK.

The surface foreman supervises all surface work not directly connected with mining. He makes the requisitions for all necessary supplies and materials, which he keeps in store, and accounts for them as they have been received and distributed. All improvements on the surface, dwellings, boarding houses, storehouses, offices, shaft houses, roads, water works, telephone lines, etc., are under his direct supervision, so also the working of the old surface ore dumps, the planilla work, stables, and transportation. He collects the rents for dwellings and ground lease, is the manager of the Helping Hand hall, and looks after the sanitary and general police regulations.

The surveyor attends to all surveying on the surface and in the mine and the mapping thereof. He makes monthly a report on the progress of the prospect work, the condition of the labores, the quantities of ore and waste rock hoisted at the different shafts, and ores sent to the hacienda reduction works.

The clerk in the hill office keeps the monthly and daily account of all labor performed and ore produced, and the pay rolls.

The chief engineer has charge of all machinery, boilers, and the blacksmith and machine shops on the hill and at the hacienda. His monthly report contains: skip loads of ore and waste rock hoisted at each shaft; trips with men and timbers; average steam pressure in pounds; average vacuum in inches; temperatures of feed water, of hot-water well, and injection water; revolutions of pumping engines; number of gallons of water raised; amount of coal used at boilers, in blacksmith shop, and for steam pumps; amount of coal and firewood on hand; quantities of different lubricants used, and other notations of interest.

Transportation is done by contract. The contractor keeps his horses and wagons at the hacienda. He provides teams at fixed contract prices, and hauls the ore from the planillas or the old surface dumps to the ore chutes at a certain price per ton. The hauling of timber, coal, wood, and other supplies is also by contract. Between 70 and 80 draft horses and mules are employed in this work.

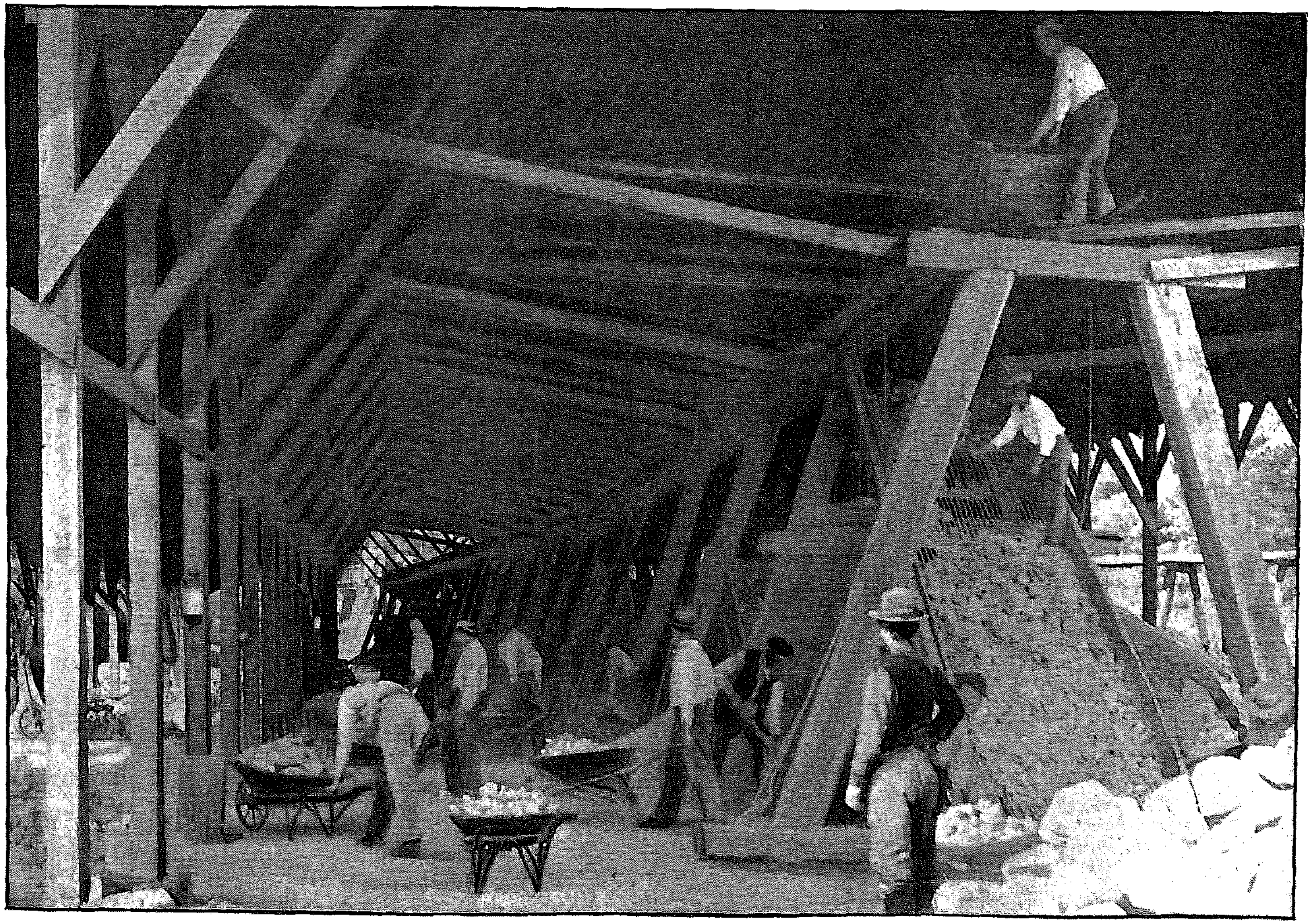
ORE DRESSING AND TRANSPORTATION.

The vein matter, just as it is broken in the labores or stopes of the mine, is run out in cars on an elevated tramway above the planilla or dressing floor belonging to each principal shaft. The most important is the Randol planilla, which is situated at the mouth of the Randol tunnel. All of the rock hoisted at the Randol shaft is trammed out through this tunnel. 6 cars, holding 1.5 tons each, are used to transport the rock. While 2 full cars are being drawn out 2 others are being filled and the other 2 are being dumped. Switches and double tracks at the shaft and mouth of the tunnel enable the change of trains to be made.

The loaded cars are received at the mouth of the tunnel by a man called the "dumper", who runs them into the planilla shed or to the "tepetate" dump, accordingly as they contain "metal" (pay ore) or barren rock from drifts and crosscuts.

The Randol planilla floor is 14.5 feet below the track. At intervals of 32 feet iron bar screens are placed which extend from the track to the floor at an angle of 45°. The screen bars are made of wrought iron and are placed from 1 inch to 1.25 inches apart. The bars are slightly chamfered in cross section to prevent choking. To prevent spreading they are stayed with cast-iron crossbars at intervals of 4 feet, and to take the sudden jar of large rocks dumped from the cars above short pieces of heavy T rails are placed longitudinally in the upper end of the screen. The sides are constructed of heavy scantlings. The outside width of the 9 screens is 5 feet. Upon these screens the metal is dumped, and what passes through is known as "tierras". The coarse fragments which fail to pass the screens are carefully picked over. On account of the tribute system it is necessary to keep the ore produced by each body of miners in a pile by itself, and as the ore produced by each company of footage men is also kept separate, the production of ore ("granza") from each level and ore stope is accurately known. The tierras are allowed to mix indiscriminately. Metal is cleaned only during the daytime, the work being done by men and boys. Rock hoisted during the night shift is dumped on the screens and cleaned the next day, the capacity of the screens being sufficient to allow this without inconvenience.

It has been already mentioned that the breaking and mining of the ores is done by two systems, one called the footage system, the other the tribute system. The ore broken by the footage system on the different levels of the



CLEANING QUICKSILVER ORE.

mine is also kept separated on the planilla in order to credit each level with the amount of ore produced. 2 or more levels are usually so represented on the planilla. For all these reasons the ores coming from different sources have to be dumped over separate screens. In cleaning, the ore which does not pass the screens is piled separately for each company of tributers and for each level, so that it may be weighed separately and credit be given accordingly. There are at times as many as 15 companies of tributers so represented on the planilla, besides the footage labores from 2 or 3 different levels, all of which have their ore piled in separate heaps.

The sorting is done very rapidly, and the rich pieces of ore picked out. All pieces of rock which do not contain any signs of metal are thrown into a car and brought to the waste dump. Large rocks containing some ore and much waste rock are piled on one side to be cleaned by spalling or breaking the rocks with sledge hammers and separating the waste rock. What is left over is taken to the pile of ore where it belongs. The cleaning of the ore in this way is speedily done.

Transportation of ore.—From the planilla floor the ore and tierras are loaded into ore wagons and weighed on platform scales. These wagons, drawn by 4 horses, hold about 3 tons of medium-grade ore, and transport the ore and tierras a distance of about 1.33 miles along a nearly level but very winding road to a series of bins, from which the ore and tierras are dumped into cars. A railroad track extends from here a distance of 1,600 feet to the head of a self-acting incline. The cars in trains are drawn over this track by a mule. The cars hold about 2 tons each, and have a gauge of 3 feet. They are lowered down the incline, the speed of descent being regulated by a brake operated by a long lever. A loaded car brings up at the same time an empty one. 3 rails form the 2 tracks of the incline, except midway, where, to avoid meeting, the cars switch apart on 2 parallel tracks. The connecting cable, a wire rope 1 inch in diameter, passes 3.5 times around an iron drum 6 feet 6 inches in diameter placed at the head of the incline. This drum is controlled by a hand brake acting upon a wheel 7 feet in diameter, and the brake levers are coupled so as to give a leverage of 57 to 1. The brake band is 6 inches wide, and consists of iron lined with hard wood. The incline trucks are surmounted by a horizontal platform upon which the ore cars rest, this platform when at either end of the incline being level with the railroad tracks. The incline is about 830 feet in length, and has a slope of about 28°. The cable is supported by wooden rollers placed between the rails at intervals of 24 feet. From the foot of the incline the cars, in trains of 5, are drawn by another mule on a track to the ore bins and screens near the furnaces. The cars are arranged to dump sidewise, being tilted up by means of levers, while at the same time the side of the car is swung open.

As already mentioned, these cars hold about 2 tons of ore or tierras, but the exact weight is never taken, as the amount shipped each day is reported from the planilla.

Two classes of ore, sorted according to size, thus reach the reduction works at the hacienda, viz, granza (coarse) and tierras (fine). Formerly, when the old dumps were being worked over, the coarse ore so obtained was called "terrero", to distinguish it from the granza of the mine. This class is no longer produced. Old dumps are still being worked for tierras, but all coarse fragments are separated by means of ore forks and rejected if waste rock, or broken small if they contain cinnabar. An intermediate size of ore called granzita is obtained, at the hacienda principally, by passing the mine tierras over screens with 1.25-inch meshes. The ore product is classified as follows:

SIZES OF ORE PRODUCT.

At the mine	Ore or granza, coarse, rich. Tierras, fine, poor.
At the works	Granza, 8 to 3.5 inches, rich. Granzita, 3.5 to 1.25 inches, poor. Tierras, 1.25 inches to dust, poor.

There are 4 screens into which the tierras from the mine are dumped. No. 1 screen consists of 36 cast-iron meshed plates 1 inch thick and 2 by 2.5 feet square. The screen is 4 plates (8 feet) wide and 9 plates (22.5 feet) long, and has an inclination of 45°. The meshes are 1.5 inches square on the upper side, and larger underneath to prevent clogging, the diagonals of the meshes being parallel to the sides of the plate. At the bottom of the screen there are 2 draw chutes, 1 for tierras and 1 for granzita. No. 3 screen is 4 plates (8 feet) wide and 5 plates (12.5 feet) long. The meshes are like those in No. 1, but the plates are placed at an angle of about 40°. No. 6 screen is 4 plates (8 feet) wide and 6 plates (15 feet) long, with an inclination of about 35°. The plates are similar to those in Nos. 1 and 3, except that the sides instead of the diagonals of the meshes are parallel to the sides of the plates—an arrangement not considered so good as that in Nos. 1, 7, and 3. 4 chutes, 2 for tierras and 2 for granzita, are provided. The ore, although screened at the mine, is again screened at the reduction works to free it from the small quantity of fine material produced by the cleansing and transportation.

4 ore bins are provided, having a capacity of 40, 80, 80, and 700 to 800 tons, respectively, all under cover. The 40-ton bin is provided with a screen consisting of longitudinal 1.5-inch wrought-iron bars 2 inches apart and 12 feet long, placed at an angle of about 40°. The ore is loaded into cars from 2 chutes. 2 chutes are also provided for the screened granzita and tierras. The 2 80-ton bins are simply inclosed incline planes, each of which has 2 chutes for discharging the ore into the cars. The 700 to 800 ton bin is a large inclosure for storing ore. Cars

for granzita and tierras are provided with screens on top of the car box. For tierras the meshes are 1.25 inches square and for granzita 2.25 by 3.5 inches.

Granzita taken from the chutes is usually charged directly into the furnaces. The surplus is stored in a shed 19 feet wide, 100 long, and 20 feet high, adjoining furnaces Nos. 1 and 2.

Tierras are rarely sufficiently dry to charge directly into the furnaces. Those containing clay are particularly objectionable, and must be thoroughly dried before being roasted. The driest tierras are dumped into No. 3 screen and brought to the tierra dump under the roof between furnaces Nos. 3 and 8, a place 60 feet square, surrounded on 3 sides by bulkheads, and are there dumped in large piles. Wet tierras are dumped into screens Nos. 1 and 6, and from there are brought into the yard during favorable weather to be spread out and exposed to the drying influences of the sun and wind.

Very wet tierras are stored aside in a shed containing room for about 3,000 tons. The tops of the condensers of Nos. 3, 6, and 8 furnaces are utilized for drying tierras spread out in thin layers over the heated surfaces. A system of tracks and floors renders this distribution very easy. The driers in connection with the first condensers of No. 6 and No. 3 furnaces are fully described in Professor S. B. Christy's article on "Quicksilver condensation at New Almaden", volume XIV of Transactions of the American Institute of Mining Engineers, 1885.

In order to raise the tierras and granzita to the level of the furnaces after the screening and drying operations are ended, 2 water-balance elevators, 1 on each side of the creek, are provided. Each elevator consists of 2 iron tanks of equal size moving in guides and connected by means of a wire rope, which passes over a sheave, and moving in 2 compartments, each formed of 4 8-inch square pieces, which serve to guide the tanks. The tanks are 4 feet by 5 feet by 2 feet deep, having platforms and tracks on top for the cars. Pits are sunk in the floor of each compartment in order to bring the platform of the tanks level with the tracks in the yard. The connecting rope is three-fourths inch in diameter, and passes 2.5 times around the sheave, 6 feet in diameter. A band brake acting on a drum (5 feet 3 inches in diameter) on the sheave controls the speed. The water for overbalancing the loaded car is introduced at the top of the elevator by means of a swinging pipe and is discharged at the bottom through an automatic valve.

The distribution of the tierras and granzita from the chutes to the various required points in the furnace yard is effected by means of wooden cars. The granzita and tierras cars hold 1,000 pounds. The boxes are 13 inches by 30 inches by 49 inches inside. The charging cars for coarse ore or granza are 1 foot 3 inches by 2 feet 9 inches by 6 feet 4 inches, and are lined with sheet iron, the capacity being 1,600 pounds. The tracks have a gauge of 2 feet, and are constructed of steel T rails weighing 12 pounds per running yard. Pivoted iron plates 43 inches in diameter are used as turntables.

WEIGHING CHARGES.

Granzita and tierras charges are estimated by the known capacity of the cars. The granza cars run over platform scales and the contents are accurately weighed, every charge of ore to be exactly 1,600 pounds.

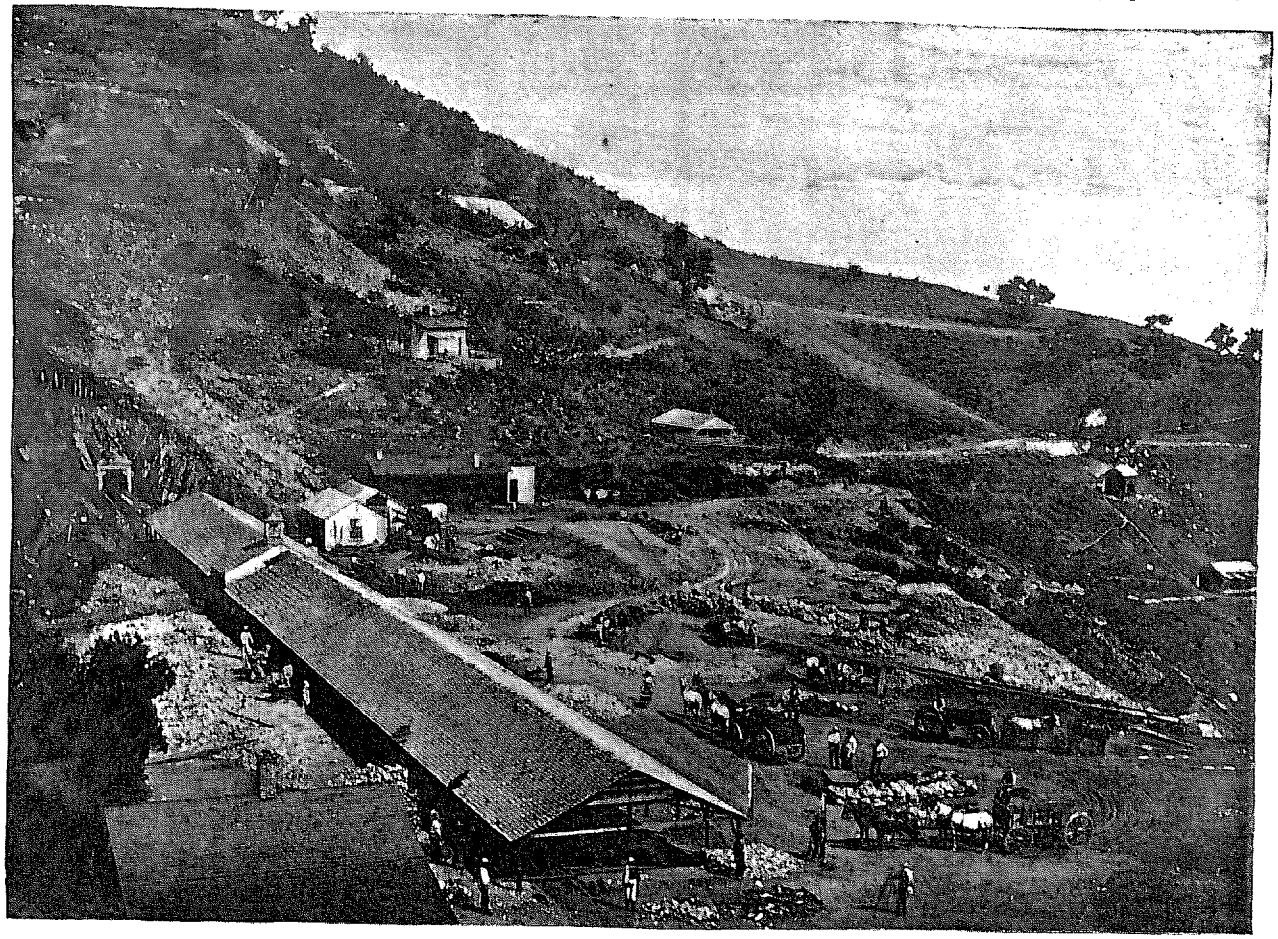
FURNACE YARD.

The furnace yard, as represented by the accompanying map, consists of about 15 acres, situated in the cañon formed by the Alamitos creek. On either side rise steep hills and rocky bluffs, and about a mile to the west is Mine Hill, which has an elevation of about 1,265 feet above the hacienda. The yard is flat and the bases of the different furnaces and condensers are approximately on the same level. The 2 granzita furnaces, Nos. 1 and 2, are on the east bank of the creek. The others are all on the west bank. The ore tramway from the mine enters on the west and follows along the hillside to the ore bins and screens, which are about 60 feet above the furnace floor.

The floors of the furnace inclosures are paved with brick, and the immediate vicinity of the furnaces, condensers, and weighing rooms are covered with a layer of cement or cement and asphaltum.

There are separate weighing and bottling rooms for each furnace except Nos. 7 and 9, 6 and 8, which have 1 room for each 2 furnaces. The floors are cemented and usually have a slope toward the center, with a small cavity to collect quicksilver if spilled. The weighing rooms contain the quicksilver vats, scales, and a number of flasks. The product of each furnace is kept separate, and the quicksilver in the vats is weighed and flasked once or twice every day. The weighing is done by the watchmen, who keep a record of the number of flasks of quicksilver weighed and sent out and the number on hand in each weighing room, and this account is handed in at the office every night. The flasks of quicksilver are piled up in the weighing room to await shipment or to be transferred to the storehouse.

The flasks now used are secondhand, being bought in the market from shippers. All old flasks require overhauling. They are carefully examined to detect cracks and holes and are then scraped inside to remove iron scales and foreign substances. If necessary, they are retapped and fitted with new stoppers. To remove the oil which they acquire in retapping they are piled in a rectangular heap and subjected to heat. Ordinary quicksilver flasks are about 12 inches long, cylindrical, 5 inches in diameter, made of wrought iron three-eighths inch thick, weigh about 13.5 pounds, and have capacity for 85 to 93 pounds of quicksilver if completely filled, but to allow for



THE PLANILLA, AT THE MOUTH OF THE MAIN TUNNEL, NEW ALMADEN QUICKSILVER MINE.

expansion a fixed quantity of 76.5 pounds is weighed in, making the gross weight of flasks and contents for shipment 90 pounds.

Wood for the furnaces is bought from private parties, who bring it to the hacienda from nearly exhausted forests 15 to 20 miles distant. The wood comes in lengths of 4 feet. For furnaces 7 and 9 the wood is cut by a machine at the hacienda into lengths of 2 feet. The wood is piled in the furnace yard and hauled to the different furnaces as needed. An accurate account of the consumption of wood for each furnace is kept, and the average amount of wood necessary for roasting a ton of ore is computed each month. The kinds of wood used are live oak, tan-bark oak, white oak, redwood, pine, manzanita, and madrone. Live oak is usually preferred to white oak, which is much inferior. Pine is good as fuel, but has rather too much flame and produces soot. Redwood makes good fuel if not more than one year old. Redwood and live oak mixed burn well and with the proper amount of heat and flame.

On account of the soot cleaning it is desirable to obtain a certain quantity of ash, which redwood alone will not produce; hence the reason for mixing it with oak wood.

RELATIONS WITH LABOR.

The population of New Almaden, depending upon the working of the mines, lives within easy reach of the mine workings, on what is called Mine Hill, on the flat slopes of which the houses and other buildings are grouped along the most accessible places. Near the oldest workings of the old mine is that portion generally inhabited by the Spanish-Americans and called Spanishtown, while farther to the north and east of Mine Hill is the so-called English camp, where the English-speaking population resides. The population numbers about 1,350 persons. Most of these are Mexicans (native Californians), and the next largest percentage is composed of Cornishmen and their offspring. Americans, English, Germans, Swedes, Italians, and a few Chinamen complete the list of nationalities.

Near the reduction works at the foot of Mine Hill is the hacienda, which consists of the furnaces, office, storerooms, workshops, and dwellings of all employés connected with the reduction works. Both places are upon the lands of the Quicksilver Mining Company, and all local arrangements and sanitary matters are therefore largely under the controlling influence of the mine manager.

The educational interests are taken care of by the state school department. A very neat schoolhouse in the English camp and a smaller one in the Spanish camp are under the direction of a principal and 3 lady teachers, and another is located at the hacienda, under the management of 1 or 2 teachers. The Quicksilver Mining Company does all in its power to foster and assist these interests. At the enumeration for the Eleventh Census there were reported 333 children between 6 and 17 years of age on the hill and 85 children at the hacienda. The average attendance is about 80 per cent in all the schools. During the last year "technical schools" were established at both settlements, furnishing instruction in blacksmithing and carpenter work for the boys and sewing and plain cooking for the girls. Although these schools were open only during the term of vacation in the public schools, very gratifying results were obtained.

There is a Catholic church in Spanishtown and a Methodist Episcopal church at the English camp. A Methodist minister resides at the camp. The Catholic church is attended on Sundays and great holidays by a priest not resident at the place. These churches were built with the aid of private contributions, assisted by the company and manager.

Only 1 saloon is permitted on the hill, and it is allowed to sell only beer and wine, other intoxicating liquors being excluded.

Benevolent institutions are of a private nature. The Englishmen have a mutual benevolent society, the members of which succor each other in times of need or sickness. and the Mexicans have 3 similar societies, called the Guadalupe society (Nuestra Señora de Guadalupe), organized February 1, 1873, and reformed in May, 1886, and the Hidalgo and Philanthropico societies.

The sanitary department is represented by a resident physician and surgeon, assisted by a competent druggist and a complete drug store. This is under the so-called miners' fund of New Almaden, established by general consent in 1870. The rules and regulations of this institution are in substance as follows:

I. Employés of the Quicksilver Mining Company, heads of families, and all other adults residing at New Almaden each pay $1 monthly into said fund. The money so contributed is held by a trustee, to be paid out for the following purposes: first, the salaries of a resident physician and druggist and for the purchase of medical supplies; second, for the relief of contributors whom circumstances may entitle to the same, and for other contingent expenses.

II. Contributors are entitled, without further payment, to the attendance of the resident physician for themselves and their immediate families, except that in cases of confinement the sum of $5 is charged, and medicines are prescribed and furnished on payment of cost.

III. When the fund is subject to any expense for relief of persons indigent or otherwise, as for medicines, nurses, and supplies, it will be regarded in the nature of a gift or as an advance to be repaid, as the trustee may decide to be just, considering the circumstances of each case.

IV. It is expressly agreed that when the resident physician is called to attend any person not a contributor to the fund there shall be a charge of not less than $5 for each visit, to be paid into the fund and to be charged against and collected from the head of the house where such noncontributor may be living.

V. The trustee serves without pay, and in consideration thereof it is understood that the foregoing rules and regulations will be observed by all persons interested therein; and it is expressly agreed that all sums due or to become due to the fund by contributors, or any of them, shall be a lien upon any property of the contributors at New Almaden and upon any money due or to become due them for wages from the Quicksilver Mining Company, which money the company is authorized to pay over to the fund without further notice.

HOSPITALS.—2 hospitals are provided, 1 in the English camp and 1 in Spanishtown, although their use is very rarely required. Nurses are paid from the miners' fund. An employé receiving an injury while on duty or at his work is supplied with medical or surgical supplies without cost, and nurses and sustenance are furnished if necessary, or support given his family during his illness and incapacity for work. Cases of destitution from ordinary sickness or other causes are deservedly considered.

The physician makes a monthly report of (1) the number of visits made each month, (2) the number of office prescriptions, (3) the number of vaccinations, (4) the number of obstetrical cases, (5) the number of cases of salivation. The druggist, who is also a clerk for the mine, makes up the prescriptions, for which he is paid an allowance of $25 per month. The accounts and collections are made by the bookkeeper of the hacienda. He also receives a compensation of $25 per month.

The company provides stabling for the physician's saddle horse, and all the necessary buildings for offices, hospitals, dispensary, and dwelling house for the physician, free of expense.

The report of the physician for the year ended November 30, 1890, is given below. The table treats only of the employés at the mine and at the reduction works. A statement on the following page deals with the entire population residing on the lands of the company.

PHYSICIAN'S REPORT AT NEW ALMADEN FOR THE YEAR 1890.

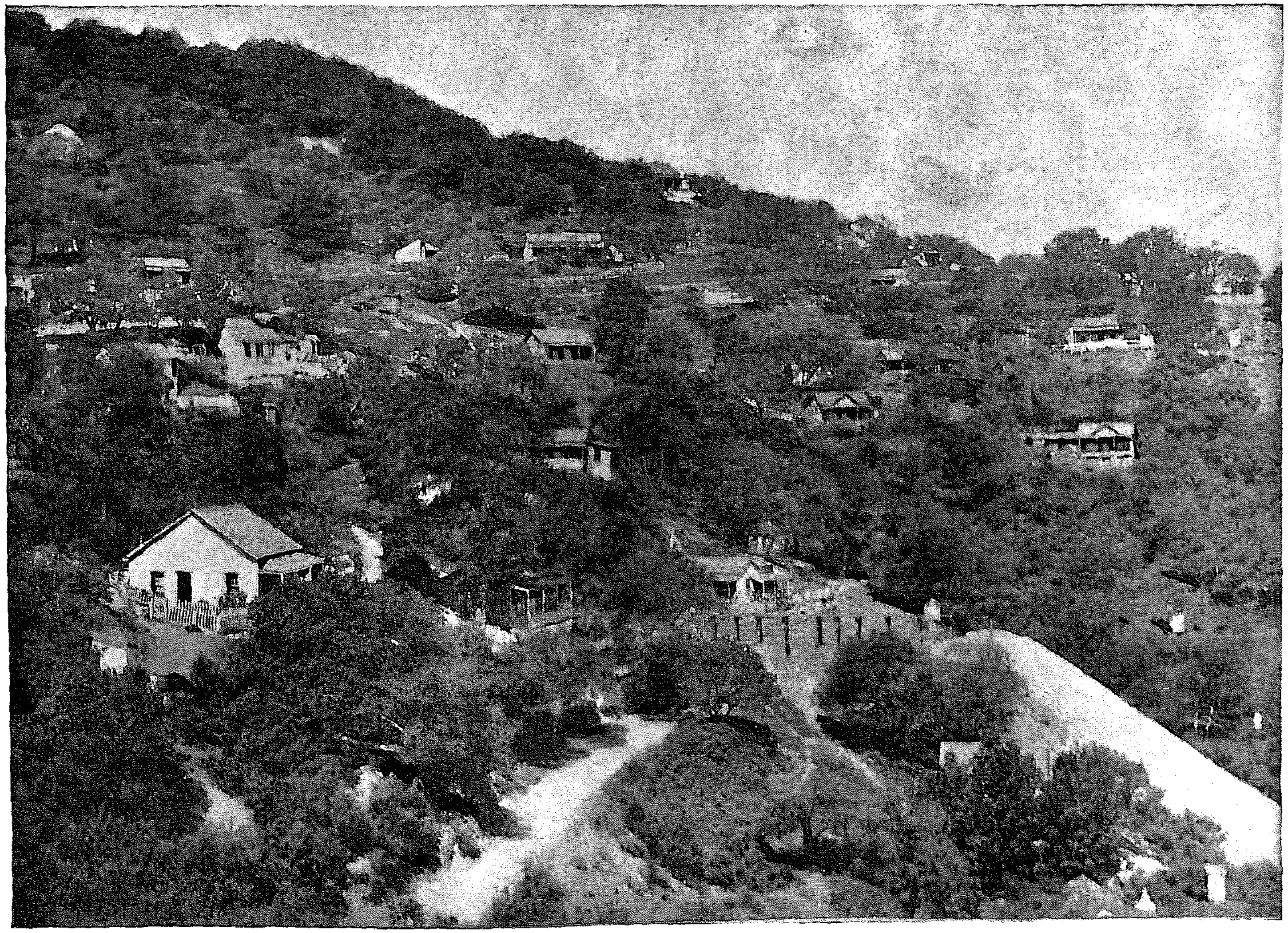
ITEMS.	MINE.		WORKS.	
	Number.	Per cent.	Number.	Per cent.
Average number of employés	316		47	
Number and per cent of cases of mercurialism	33	10.44		
Number and per cent of serious accidents	5	1.58		
Number and per cent of new cases	267	84.50	55	117.02
Total new cases of all kinds	305	96.52	55	117.02
Deaths	3	a9.49		

a Per thousand.

The above table shows a decided difference in the salivation rate at the mine in comparison with that at the works, and, being so remarkable, is well worthy an inquiry as to its cause. This difference may in a measure be explained as follows: the miners employed in the extraction of ore work by contract as a rule, and a certain number of careless men, through their own negligence, become victims to mercurial salivation. Men engaged in ore chambers where native mercury is found are requested not to eat, drink, or smoke without first cleaning the face and hands and using a solution of potassium chlorate as a mouth wash. Working stripped to the waist is discouraged.

As the greatest attention is paid toward the attainment of perfect ventilation, which is of prime importance in the prevention of mercurial sickness, it is the physician's belief that if the miners were more thorough in the use of the above precautions the salivation rate at the mine would be under 1 per cent, whereas it is now over 10 per cent It is probable that there will always be a slight amount of mercurial sickness, owing, very likely, to the suspension in the moist atmosphere of the mine of a small amount of the chlorides and possibly other salts of mercury. The absolute immunity from mercurialism of the men employed at the reduction works may be explained on the following grounds, viz: to the thorough sealing of furnaces, condensers, and flues; to the use of forced draft by means of fans; to the discontinuance of soot-cleaning by hand; to the medical prophylaxis, which consists solely in the use of a saturated solution of potassium chlorate as a mouth wash after the slightest exposure to mercurial vapor or other noxious fumes; to the employment at the works of a careful, faithful, and comparatively temperate class of men, this last characteristic being in no small degree responsible for the absence of mercurial sickness; lastly, to the increasing experience now obtaining in the proper reduction of quicksilver ores, and to the efforts on the part of the management to secure absolute immunity from mercurial salivation through the use of the most approved apparatus and appliances. There were but 5 accidents of a serious nature, all of them being fractures, none of which proved fatal.

The high and greatly abnormal sick rate was due to the prevalence of the grippe epidemic in the winter of 1889 and spring of 1890, yet no fatal cases resulted therefrom. The 3 deaths reported as occurring at New Almaden



HILLSIDE COTTAGES, ENGLISH CAMP, NEW ALMADEN QUICKSILVER MINES.

mine were caused by parenchymatous nephritis, pyæmia, and erysipelas following a gunshot wound. A special census taken during December, 1890, gives the information contained in the following table:

SPECIAL CENSUS AT NEW ALMADEN IN 1890.

ITEMS.	Total.	SPANISH-AMERICAN.				ANGLO-AMERICAN AND OTHERS.			
		Over 5 years.		5 years and under.		Over 5 years.		5 years and under.	
		Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.
Hill (mine)	1,132	282	190	47	42	283	214	39	35
Hacienda (works)	223	24	22	4	6	91	57	11	8
Total	1,355	306	212	51	48	374	271	50	43
Number of deaths	25	4	6	7	2	1	2	2	1
Number of births	48	....	26	....	....	....	20	....	....

The analysis of this table shows the following death rate:

DEATH RATE AT NEW ALMADEN IN 1890.

	PER 1,000.
Spanish-American	30.8
Anglo-American (including other nationalities)	8.1
Average death rate	18.5

BIRTH RATE AT NEW ALMADEN IN 1890.

	PER 1,000.
Spanish-American	45.4
Anglo-American (including other nationalities)	27.1
Average birth rate	35.4

The difference in the mortality rate between the Spanish-Americans and the Anglo-Americans, which includes some of other nationalities, is noteworthy, as the 2 classes are living under similar climatic conditions; yet tubercular disease is very common with the former class and caused 10 deaths, while with the latter class not a single case is to be remarked. The diseases which caused death were tuberculosis, 10; cholera infantum, 3; capillary bronchitis, cancer, peritonitis, laryngismus (stridulous), meningitis, erysipelas, tetanus, nephritis, diphtheria, pyæmia, and injuries following a burn, 1 each. Excepting the grippe and measles, no disease has been epidemic during the past year, a fact which serves as a criterion of the excellent hygienic conditions at present existing.

THE HELPING HAND.—A social organization, called the Helping Hand Club, for which the company built and fitted up comfortable houses, on the hill as well as at the hacienda, induces pleasant intercourse among the inhabitants. The hall building at the hacienda is a modern structure in very attractive style, having on its lower floor a large assembly hall and stage for concerts or other entertainments, adjoined by reading and dressing rooms, while the upper floor is divided into 4 bedrooms, for the use of visitors or guests at the reduction works. On the hill the building consists of a large assembly hall, with stage and dressing rooms, a reading room, and kitchen, all on one floor. Both halls are provided with pianos, purchased by the club managers with surplus funds from entertainments given, and the reading rooms have small libraries besides a list of monthly magazines and the best daily and weekly newspapers. The halls are warmed and lighted by the company, and admission is free to all residents at the mine and reduction works who are employés of the company. Entertainments of musical or dramatic character are here given by the club members, and at other times the halls are provided with card tables, where the members may enjoy a pleasant game of checkers, chess, or cards. Every encouragement is given to residents for domestic or public comfort, and the result of this patriarchal régime is seen in the fact that many of the miners have worked here uninterruptedly for 30 years or more; some, in fact, have been born on the soil, are now heads of families, and consider the mine their home for life.

The great majority of the workmen are married and have families, and this class of labor is encouraged and fostered as much as possible, as it forms a more reliable and responsible element than could be had by engaging single men without domestic ties, liable to roam at any moment. It is hardly necessary to add that strikes have never occurred, and are not likely to occur as long as this reciprocated feeling of trust and good will exists between the management and the employés.

The single men employed are boarded and lodged in boarding houses, of which there are 2 on the hill, 1 for the English speaking and 1 for Spanish men. Both are large, substantial dwellings with all the comforts of domestic life, large, well-ventilated dining rooms and sleeping rooms neatly furnished, while there are in the basement rooms in which to change and dry the damp clothing brought from the mine. At the hacienda a similar boarding house, furnished by the company, is kept for single men or visitors. The sleeping rooms for workmen are arranged in a separate building, a similar one being also on the hill.

HOURS OF WORK.—The hours of work on the surface are from 7 o'clock in the morning until 6 o'clock in the evening, allowing 1 hour at noon for dinner or lunch. Miners go into the mine at 7 o'clock in the morning and evening and leave the mine at 5 in the evening and morning, respectively. 1 hour at noon and midnight is allowed for lunch and rest, which, allowing half an hour's time to reach their working places and as much for returning to the surface, makes 8 hours of solid work in the mine.

On Sundays and national holidays work is stopped in the mines and on the surface, except at the pumps of the Buena Vista shaft, which are continued without interruption.

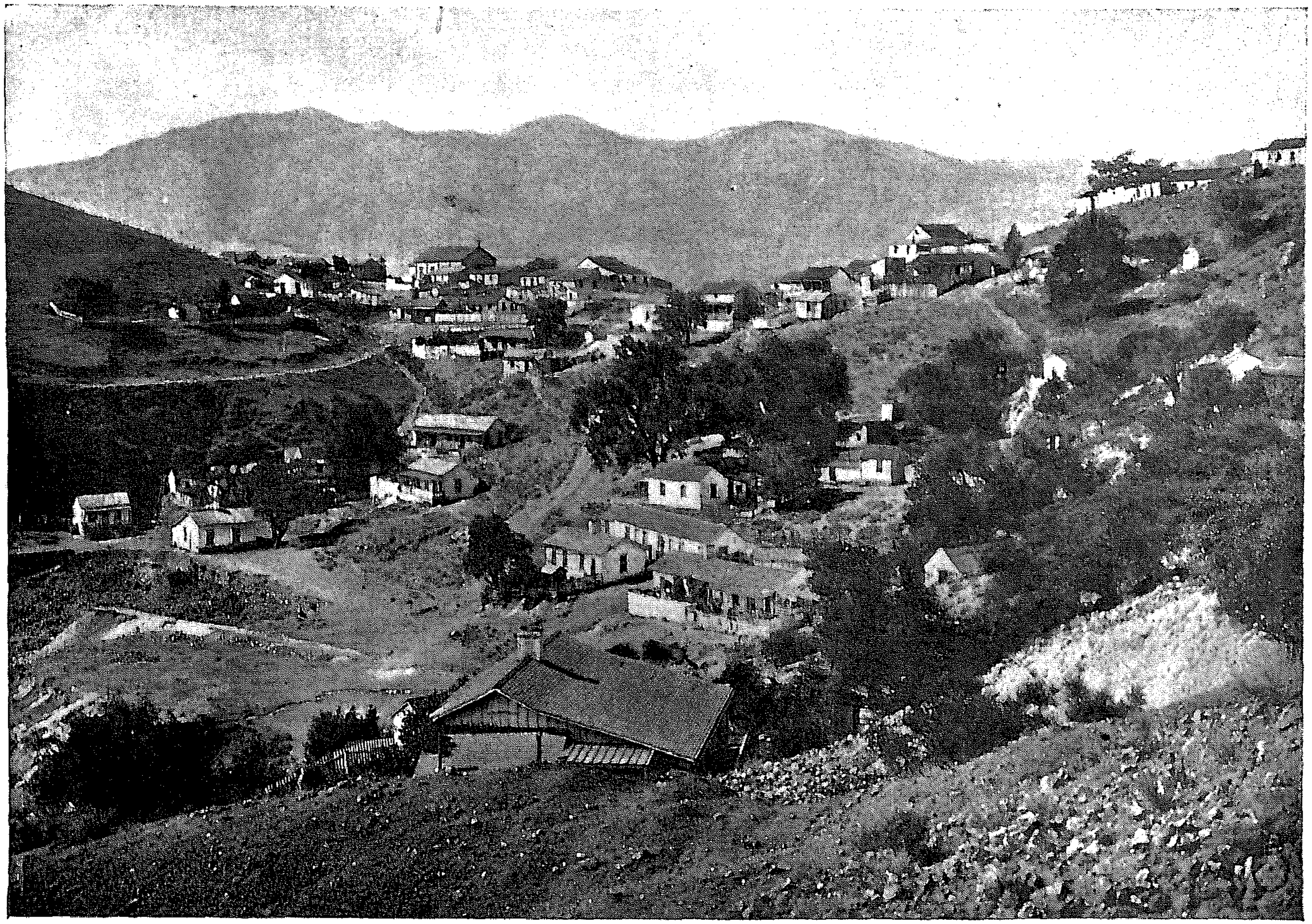
PRODUCTION OF QUICKSILVER AT NEW ALMADEN.

Up to August 31, 1863, the New Almaden mines had produced 23,619,834 pounds of quicksilver, equal to 308,756 flasks of 76.5 pounds each, from 51,157 short tons of ore, or 461.7 pounds to the ton, an average of 23.09 per cent. Including the above, the total to the close of 1889 amounted to 69,191,113.5 pounds, or 904,459 flasks.

PRODUCT OF QUICKSILVER AT NEW ALMADEN FOR 37 YEARS AND 3 MONTHS.

DATES.	Total pounds of ore roasted.	Total flasks of quicksilver produced.	Yield of quicksilver. (Per cent.)	DATES.	Total pounds of ore roasted.	Total flasks of quicksilver produced.	Yield of quicksilver. (Per cent.)
Total and average	1,262,789,640	a893,888	5.41	January, 1869, to December, 1869	25,458,175	16,898	5.08
July, 1850, to June, 1851	4,970,717	23,875	36.74	January, 1870, to December, 1870	21,097,700	14,423	5.23
July, 1851, to June, 1852	4,643,290	19,921	32.82	January, 1871, to December, 1871	22,034,700	18,568	6.45
July, 1852, to June, 1853	4,839,520	18,035	28.51	January, 1872, to December, 1872	21,416,600	18,574	6.63
July, 1853, to June, 1854	7,448,000	26,325	27.04	January, 1873, to December, 1873	17,330,375	11,042	4.87
July, 1854, to June, 1855	9,109,300	31,860	26.76	January, 1874, to December, 1874	23,454,000	9,084	2.96
July, 1855, to June, 1856	10,355,290	28,083	20.75	January, 1875, to December, 1875	31,106,200	13,648	3.36
July, 1856, to June, 1857	10,299,900	26,002	19.31	January, 1876, to December, 1876	33,316,950	20,549	4.72
July, 1857, to June, 1858	10,997,170	29,347	20.41	January, 1877, to December, 1877	37,231,300	23,996	4.93
July, 1858, to October, 1858	3,873,085	10,588	20.91	January, 1878, to December, 1878	36,942,225	15,852	3.28
November, 1858, to January, 1861	....	....	....	January, 1879, to December, 1879	55,065,135	20,514	2.85
February, 1861, to January, 1862	13,323,200	34,765	19.96	January, 1880, to December, 1880	61,354,850	23,465	2.93
February, 1862, to January, 1863	15,281,400	40,391	20.22	January, 1881, to December, 1881	64,141,135	26,060	3.11
February, 1863, to August, 1863	7,172,660	19,564	20.87	January, 1882, to December, 1882	72,147,200	28,070	2.98
September, 1863, to October, 1863	2,346,000	5,520	18.00	January, 1883, to December, 1883	77,162,500	29,000	2.88
November, 1863, to December, 1863	2,359,300	4,447	14.42	January, 1884, to December, 1884	79,251,000	20,000	1.93
January, 1864, to December, 1864	23,277,600	42,489	13.96	January, 1885, to December, 1885	79,069,300	21,400	2.07
January, 1865, to December, 1865	31,948,400	47,194	11.30	January, 1886, to December, 1886	81,398,690	18,000	1.69
January, 1866, to December, 1866	26,885,300	35,150	10.00	January, 1887, to December, 1887	64,151,300	20,000	2.38
January, 1867, to December, 1867	26,023,933	24,461	7.19	January, 1888, to December, 1888	57,325,600	18,000	2.40
January, 1868, to December, 1868	29,405,530	25,628	6.67	January, 1889, to December, 1889	57,775,200	13,100	1.73

a Additional product of Enriquita mine from 1860 to 1863, 10,571 flasks.



MEXICAN CAMP NEW ALMADEN QUICKSILVER MINES.

WAGES AT NEW ALMADEN IN 1889.

EMPLOYÉS.	Per month.	Per day.
MINE.		
Machinists	$100.00	
Machinist's helpers	$60.00 to 75.00	
Engine drivers	70.00 to 80.00	
Firemen	40.00 to 60.00	
Blacksmiths	45.00 to 60.00	
Blacksmiths' helpers	30.00 to 35.00	
Pumpmen	71.00 to 90.00	
Shaftmen	71.00	
Blasters	71.00	
Boilermakers		$2.00 to $2.50
Timbermen (shaftmen)		2.00 to 2.50
Carpenters		3.00
Surface laborers		1.50 to 2.00
Ore cleaners		1.75 to 2.00
Laborers in labores		1.50 to 2.00
Trammers		1.75 to 2.25
Skip fillers		2.00
Landers		1.25 to 1.75
Boys		1.00 to 1.50
HACIENDA.		
Furnace foremen	100.00	
Weighers	85.00	
Machinists	70.00 to 100.00	
Mason	150.00	
Blacksmith		3.00
Blacksmiths' helpers		1.25 to 2.00
Carpenters		3.00
Engine drivers	50.00	
Laborers		2.00 to 2.25
Furnacemen (trammers)		2.00
Furnacemen (firemen and chargers)		2.50
Sootmen		2.10
Transportation, 2-horse teams		4.00
Transportation, 4-horse teams		6.00

SUPPLIES CONSUMED DURING THE YEAR 1889.

ITEMS.	At mine.	At hacienda.
Total	$54,855.15	$31,573.33
Bricks	1.20	38.99
Candles and oils	1,816.40	778.31
Castings and foundry work	144.25	743.93
Coal	19,539.63	2,346.51
Hay and grain	1,031.67	2,064.40
Iron, steel, and hardware	3,128.40	1,062.77
Lagging	1,557.24	
Lime and cement	24.77	82.77
Lumber and timber	17,247.26	2,167.39
Powder, fuse, and caps	2,081.17	
Railroad iron	339.20	28.06
Sundries	2,273.30	1,607.85
Wood	5,670.66	13,738.24
Flasks		6,914.11

DRIFTING, SINKING, AND PROSPECTING ("DEAD WORK") AT NEW ALMADEN.

Year	FEET.
1880	5,144.79
1881	4,574.25
1882	9,133.00
1883	6,699.50
1884	6,814.50
1885	11,370.50
1886	11,926.00
1887	10,766.50
1888	9,582.00
1889	10,169.00
Total	86,180.04

TABLE SHOWING AMOUNT AND COST OF PRODUCTION OF ORE AND QUICKSILVER AND OF PROSPECT WORK AT NEW ALMADEN, 1880 TO 1889, INCLUSIVE.

YEARS.	Total tons of rock, vein matter, and ore extracted from the mine.	Total tons of granza ore shipped to reduction works.	Total tons of tierras ore shipped to reduction works.	Total tons of all ore shipped to reduction works.	Total tons of all descriptions of ore roasted.	Flasks of quicksilver of 76.5 pounds each produced.
Total	1,109,770.28	73,916.89	263,088.66	337,005.55	346,888.39	217,095
1880	83,666.79	a7,527.67	b4,145.30 a12,125.50	23,798.47	30,677.43	23,465
1881	90,295.65	a8,020.75	b11,697.70 a14,097.50	33,815.95	32,070.57	26,060
1882	120,222.57	a9,236.43	b10,274.00 a14,705.81	34,216.24	36,073.60	28,070
1883	117,579.45	a9,584.20	b11,214.32 a20,289.24	41,087.76	38,581.25	29,000
1884	126,139.61	b8.00 a7,624.23	b11,596.79 a20,038.20	39,267.22	39,625.50	20,000
1885	138,639.52	b81.37 a8,484.77	b4,010.59 a25,039.91	37,616.64	39,534.65	21,400
1886	120,398.85	b183.70 a7,183.96	b5,900.61 a24,717.72	37,985.99	40,699.34	18,000
1887	115,004.15	b60.52 a6,214.52	b7,114.95 a19,642.95	33,032.94	32,075.65	20,000
1888	99,166.54	b22.18 a5,060.95	b4,896.82 a18,196.44	28,176.39	28,662.80	18,000
1889	98,657.15	b24.59 a4,599.05	b3,605.75 a19,778.56	28,007.95	28,887.60	13,100

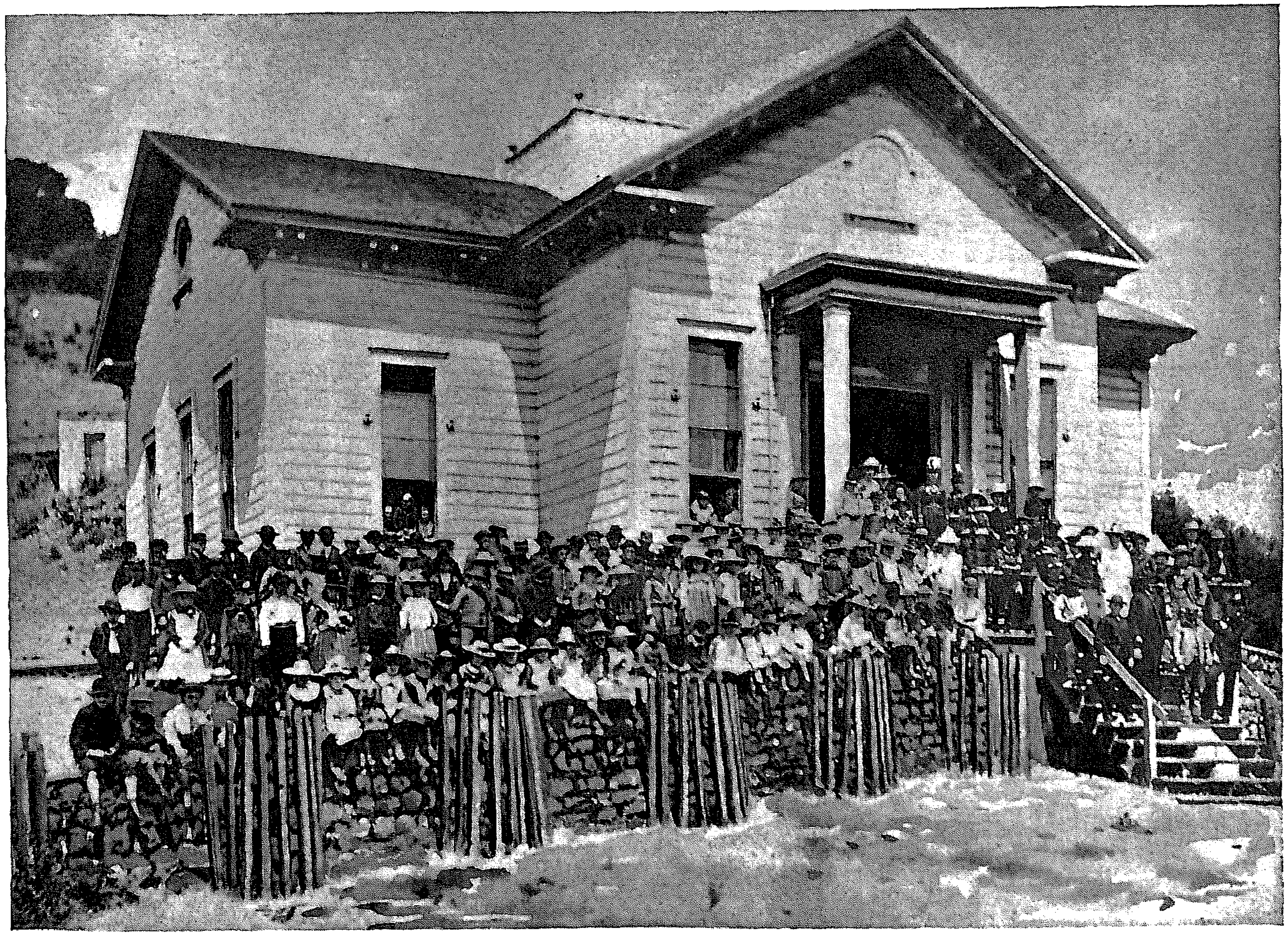
YEARS.	Average yield of all ores roasted. (Per cent.)	Cost per ton for mine supplies, timber, powder, fuse, iron, steel, lagging, candles and oils, railroad iron, and sundries.	Cost for labor per ton for all matter mined.	Cost per ton for all ore delivered at the furnaces; labor, supplies, and transportation.	Cost per flask, embracing all expenses, less receipts from rentals and other sources. (c)	Number of yards drifted, sunk, etc.	Average price paid per yard, not including supplies.
Total and averages	2.39	$0.60	$2.38	$10.46	$21.09	28,110.32	$23.61
1880	2.93	0.62	2.22	10.40	15.25	1,714.93	22.30
1881	3.11	0.55	2.11	7.37	13.35	1,524.75	30.61
1882	2.98	0.59	2.29	10.45	17.13	3,043.63	26.69
1883	2.88	0.65	2.16	8.34	16.10	2,006.87	25.52
1884	1.93	0.74	2.15	9.62	24.00	1,836.53	29.27
1885	2.07	0.88	2.34	12.23	26.75	3,871.58	25.30
1886	1.69	0.82	2.66	11.33	29.14	3,954.18	22.25
1887	2.38	0.71	2.59	11.82	24.75	3,553.82	23.76
1888	2.40	0.71	2.81	12.76	25.24	3,276.45	21.65
1889	1.73	0.55	2.49	11.10	30.41	3,327.58	16.96

a From mine proper. b From surface workings. c Does not include increase or decrease of ore account at hacienda.

THE PRODUCTION OF VERMILION.

As the result of inquiries made, it was reported that 6 manufacturing establishments in the city of New York consumed in 1889 535,728 pounds of quicksilver, equal to about 7,003 flasks, in the manufacture of 600,047 pounds of vermilion.

The manufacturers of mercurial preparations absolutely declined to give any account of the quicksilver consumed in the manufacture of their several products, on the ground that it was impossible to separate the figures, but after much difficulty the aggregate amount of quicksilver consumed by 2 firms was ascertained to be, respectively, 750 and 1,754 flasks. As the desired information could not be acquired from all the manufacturers, the foregoing statement of consumption is only an approximation.



HILL SCHOOL, NEW ALMADEN QUICKSILVER MINES.

CONSUMPTION OF QUICKSILVER IN MILLING GOLD AND SILVER ORES.

The following statement has been prepared, after special study of the mines mentioned, to show the quantity of quicksilver consumed in gold and silver milling. The limits are very great, due partly, of course, to the great difference in character of the ores treated, but very greatly also to skill in mill practice.

CONSUMPTION OF QUICKSILVER PER TON OF ORE WORKED.

Years.	Mines.	States and territories.	Number of mills.	Ore worked. (Tons.)	Quicksilver consumed. (Pounds.)	Quicksilver consumed. (Pounds per ton.)
1889	Bimetallic (silver)	Montana	1	23,215	43,528	1.87
1889	Elkhorn (silver and lead)	...do	1	8,712	13,387	1.54
1889	Hope	...do	1	6,634	8,803	1.33
1887	...do	...do	1	8,091	7,889	0.98
1888	...do	...do	1	8,962	9,231	1.03
1885	Montana (limited) (gold and silver)	...do	1	33,482	46,545	1.39
1886	...do	...do	1	41,728	50,235	1.20
1887	...do	...do	1	75,005	48,434	0.65
1888	...do	...do	1	83,745	21,503	0.26
1889	...do	...do	1	78,749	38,638	0.49
1889	Ontario (silver and lead)	Utah	1	34,733	35,580	1.02
1886-1889	Blue Bird (silver)	Montana	1	103,076	85,474	0.83
1884-1889	Granite Mountain (silver)	...do	1	120,000	96,000	0.80
1883	Lexington (gold and silver)	...do	1	20,281	16,667	0.82
1884	...do	...do	1	22,138	13,120	0.59
1885	...do	...do	1	20,749	16,141	0.78
1886	...do	...do	1	21,379	6,688	0.31
1887	...do	...do	1	23,789	9,678	0.41
1888	...do	...do	1	24,594	13,594	0.55
1889	...do	...do	1	26,361	13,497	0.51
1888-1889	Empire (gold)	California	1	....	....	0.06
1888	North Star	...do	1	17,259	842	0.05
1889	...do	...do	1	20,525	995	0.05
1889	Treadwell	Alaska	1	218,000	2,725	0.01
1880-1890	Homestake	South Dakota	1	2,159,011	14,536	0.01
1880-1890	Idaho (gold and silver)	California	1	278,830	7,879	0.03

At the Bimetallic mine, in Montana, the ore is base silver. It all requires roasting. The average composition of the ore is as follows:

AVERAGE COMPOSITION OF ORE FROM THE BIMETALLIC MINE, MONTANA.

	Per cent.		Per cent.
Silica	64.50	Arsenic	1.53
Iron	7.70	Antimony	0.55
Manganese	2.52	Zinc	5.80
Lime	2.70	Silver	3.07
Sulphur	8.45		
Lead	2.73	Total	100.00
Copper	0.45		

The ore of the Montana (limited) mine contains gold and silver in the proportion of about 64 per cent gold and 36 per cent silver. The gangue is quartz, with a small quantity of broken slate. The ore is free milling, and is treated by the "combination process" of amalgamation before concentration. The principal base in the quartz is copper, of which there is a slight amount, as well as a trace of lead and a very small percentage of manganese.

At the Ontario mine in Utah the country rock is quartzite and limestone; the gangue is quartz; fahlore is the principal silver-bearing mineral, containing galena, zinc blende, copper, and iron pyrites, carrying comparatively little silver and a trace of gold. Near the surface, and also in many portions of the mine below the water level, the sulphurets are more or less decomposed and oxidized. The ore first mined was free milling. At present all the ore has to be subjected to a chloridizing roasting before amalgamation.

There are 2 classes of ore shipped from the Ontario mine. The first, containing from 70 to 80 ounces of silver and from 10 to 12 per cent lead per ton, is sold to the smelters; the second, containing from 35 to 50 ounces silver per ton, with a small percentage of lead, is reduced at the home mill. The percentage of copper and zinc in the ore varies more or less, and has never been accurately determined.

At the Lexington mine, Montana, the gangue is quartz. The ore averages 1 ounce in gold and 50 ounces of silver. The process of reduction is dry crushing, chloridizing, roasting, and amalgamating in pans. Other metals are iron, copper, lead, and zinc as sulphurets, in various proportions, the average being for these sulphurets about

10 per cent, with from 10 to 20 per cent of other gangue material, not quartz, consisting of manganese spar and calc-spar.

The Empire mine, California, has a quartz gangue. The ore is free-milling gold. There are no other metals to speak of in the gangue matter.

The Idaho mine, California, has quartz for the gangue, and the ore yields gold and silver combined; gold about 85.4 to silver 14.6. It is free milling. There are no other metals of value.

At the Granite Mountain mine the ore contains silver, with about one-tenth of an ounce per ton of gold. The ore is refractory, requiring roasting in order to be chloridized and desulphurized. The contents of the average ore are about as follows:

COMPOSITION OF GRANITE MOUNTAIN ORE.

	PER CENT.		PER CENT.
Silica	80	Sulphur	8
Iron	6	Zinc	2
Arsenic	2	Antimony	1
Copper	Trace.		

The zinc, iron, etc., are found in the form of sulphides. The vein matter, outside of the quartz, is mostly decomposed granite.

The Hope mine, Montana, yields silver ore—no gold. It is free milling, not roasted; contains manganese in varying quantities, usually a small percentage. The gangue is blocky quartz, with sulphurets and chloride of silver, between yellow limestone walls, with yellow clay on the hanging wall.

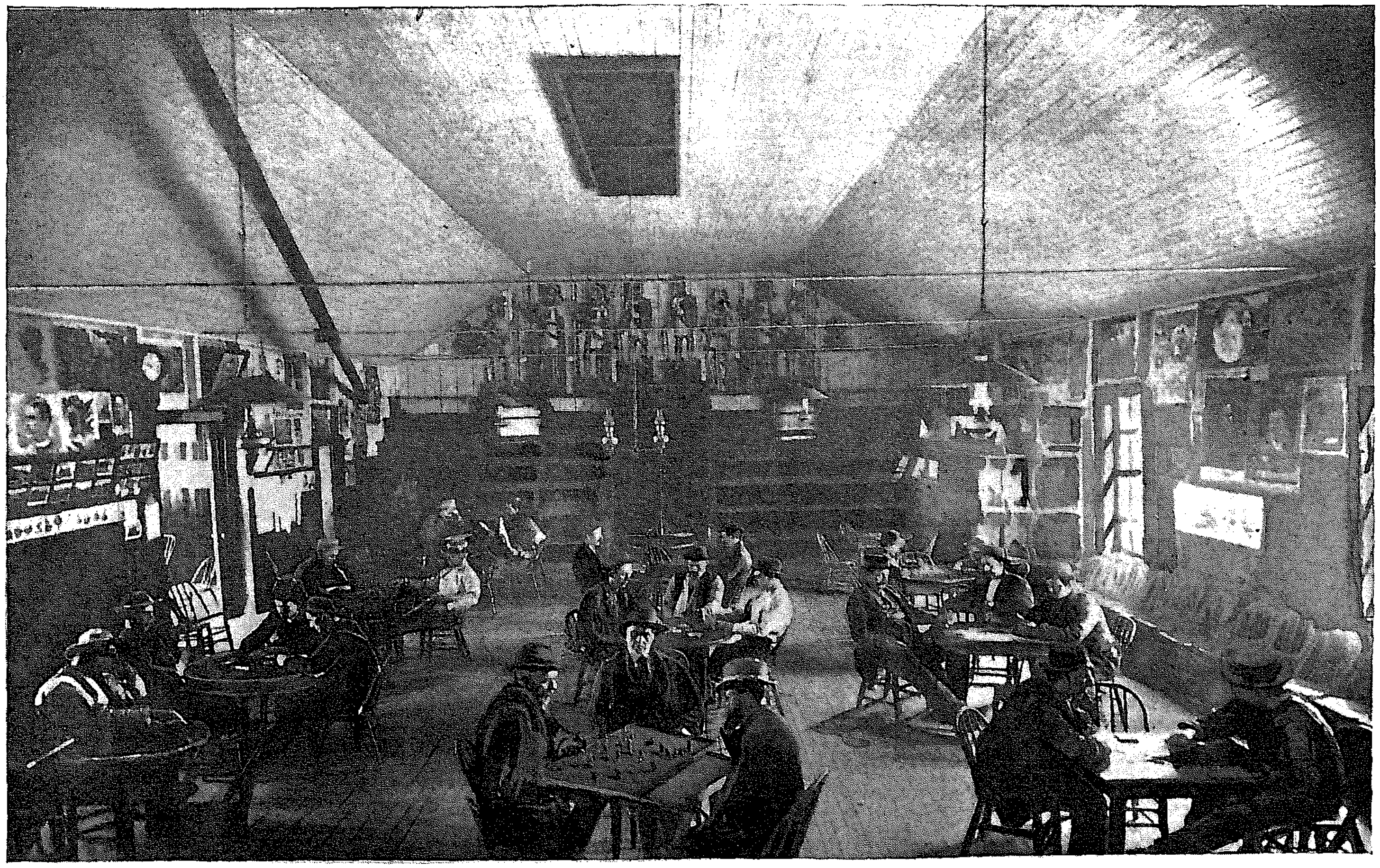
CONSUMPTION OF QUICKSILVER ON THE COMSTOCK LODE, NEVADA.

The following table gives the tons of Comstock ore worked, the amount of quicksilver consumed for each year, and the average number of pounds of quicksilver consumed per ton of ore worked for the period stated. The table does not include all the working mills for the several years given, but does include nearly all those mills that have kept reliable data. These mills were located in Storey, Lyon, and Ormsby counties, in Nevada.

CONSUMPTION OF QUICKSILVER IN MILLING THE ORES OF THE COMSTOCK LODE.

YEARS.	Number of mills.	Ore worked. (Tons.)	Quicksilver consumed. (Pounds.)	Quicksilver consumed per ton. (Pounds.)
Total	50	1,268,083	2,498,248	1.97
1880	6	130,578	246,347	1.89
1881	4	47,890	91,352	1.91
1882	4	81,110	142,665	1.76
1883	5	95,993	176,201	1.84
1884	3	83,120	157,646	1.90
1885	3	78,689	131,934	1.68
1886	5	192,837	371,570	1.93
1887	6	159,666	387,655	2.43
1888	7	195,203	415,077	2.13
1889	7	202,997	377,801	1.86

The table following gives the tons of Comstock tailings worked, the amount of quicksilver consumed for each year, and the average number of pounds of quicksilver consumed per ton of ore worked for the period stated. In addition to the remarks for the ore table, it may be stated that the results are not so uniform, due doubtless to the presence at times of foreign matter that sometimes unavoidably gets into the tailings during the rainy season, and other causes not known. The percentage of loss is less, because the tailings already hold quicksilver.



"HELPING HAND" CLUB ROOM, NEW ALMADEN QUICKSILVER MINES.

CONSUMPTION OF QUICKSILVER IN WORKING COMSTOCK TAILINGS.

YEARS.	Number of mills.	Ore worked. (Tons.)	Quicksilver consumed. (Pounds.)	Quicksilver consumed per ton. (Pounds.)
Total	22	400, 075	368, 920	0. 92
1880	4	104, 056	86, 680	0. 83
1881	5	68, 714	44, 451	0. 65
1882	3	42, 583	43, 987	1. 03
1883	2	19, 514	34, 346	1. 76
1884	2	39, 871	38, 960	0. 98
1885	2	29, 527	23, 945	0. 81
1886	1	31, 164	32, 752	1. 05
1887	1	19, 806	17, 694	0. 89
1888	1	24, 154	24, 585	1. 02
1889	1	20, 686	21, 520	1. 04

The following table includes all the quicksilver shipped over the Virginia and Truckee railroad into Nevada during the period from 1880 to 1889, both years inclusive. The number of flasks was not reported by the railroad officials at Carson, only the tons and pounds, and the flask has been taken as weighing 90 pounds, gross.

QUICKSILVER SHIPPED OVER THE VIRGINIA AND TRUCKEE RAILROAD, NEVADA, FOR 10 YEARS.

YEARS.	Tons and pounds.		Total in pounds.	Flasks.
Total	2, 156	66	4, 312, 066	47, 912
1880	110	1, 800	221, 800	2, 464
1881	119	1, 554	239, 554	2, 662
1882	120	1, 615	241, 615	2, 685
1883	150	1, 278	301, 278	3, 347
1884	174	1, 535	349, 535	3, 884
1885	267	1, 449	535, 449	5, 949
1886	360	......	720, 000	8, 000
1887	290	1, 180	581, 180	6, 458
1888	375	150	750, 150	8, 335
1889	185	1, 505	371, 505	4, 128